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Gauging Our Water Quality. An Analysis of Conditions and Trends in North Central Texas Lakes and Rivers

North Central Texas Council of Governments, Arlington

Prepared for

Environmental Protection Agency, Dallas, Tex Region VI

Apr 77

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. Abstracts

This document presents existing and available water quality data, both recent and historical, for the Dallas-Fort Worth 208 Area. Consideration is given to water analyses , tributary analyses, and sediment analyses, as well as various biological parameters. Temporal and spatial trends are examined.

This is a final report; the draft version (NCTCOG/WR-76/04) of this report was published in December 1976.

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Gauging Our Water Quality -
An Analysis of Conditions and Trends in North Central Texas Lakes and Rivers

The review draft of this document has undergone extensive examination by NCTCOG technical and policy committees and interested individuals. Recommendations approved by the various committees have been incorporated into this final printing. This document has been endorsed and approved for distribution by the Areawide Planning Advisory Committee.

Prepared for the North Central Texas Council of Governments
by the Planning and Environmental Management Division
Trinity River Authority of Texas

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April 1977

1a

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The bulk of the text was written by K.C. Rudy, and the majority of the graphics were prepared by Paul Hutchinson. Other TRA personnel who were instrumental in the preparation of this report include Tony Chen, P.E., John Cofer, Dixie Drake, and Fred Gonzalez. The typing was done by Susan Price and Janay McWilliams. The project was under the overall direction of Richard Browning, Ph.D.

Herman Veselka, P.E., Director of Water Resources, and Charles Bayer, Staff Biologist, were the main sources of input from the North Central Texas Council of Governments. Their comments were very helpful in completing the report.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Available water quality data were gathered and assessed in order to produce the clearest picture of water quality conditions in the designated Dallas-Fort Worth 208 Area. Chemical quality data were abundant for each of the seven Presentation Areas under consideration. By and large, however, data were insufficient for a detailed analysis of point vs. nonpoint source input to the Trinity River.

Groundwater in the Dallas-Fort Worth Area appears to be fairly sufficient in both quality and quantity to serve as an auxiliary source of water for a number of years. Several samples, however, contained high concentrations of dissolved solids, chloride, sulfate, and fluoride.

Present water quality conditions in the major reservoirs within the Dallas-Fort Worth 208 Area can be considered generally good. Some eutrophic symptoms occur within all of them: summer stratification with substantial hypolimnetic oxygen depletion and nutrient buildup, phytoplankton overabundance with occasional taste and odor problems, and adequate nutrient concentrations to sustain large macrophyte and phytoplankton communities. In general, fish community structure appears to have shifted to predominantly rough fish in most of the reservoirs. This does, however, represent natural conditions.

Stream segments generally exhibit acceptable water quality. The Main Stem Trinity River and the East Fork exhibit chronic problems with dissolved oxygen and fecal coliform, while the Elm Fork exhibits problems (i.e., occasional high concentrations) with fecal coliform. It should be noted, however, that the TWQB (1976a) fecal coliform standard for the Elm Fork is 1/10 the standard of the Main Stem Trinity River (i.e., 200 as compared to 2000 organisms/100 ml).

Difficulty in discerning trends in water quality resulted from many parameter's relationship with flow. Many parameters, such as chloride, sulfate, and various nutrients exhibit an inverse relationship with flow. Consequently, annual mean data for "wet" years are not strictly comparable to similar data for "dry" years. Some time-weighted and flow-weighted data were analyzed for the Main Stem Trinity River for total dissolved solids, but no trends were noticeable.

Figure ES1 provides a synoptic tabulation of the present and past status of various water quality parameters. Biological assessments for columns under the "Other Water Quality Indicators" heading took into account the diversity of organisms present and the proportion of undesirable (or pollution-tolerant) species. Nutrient assessments were made based upon accepted literature values of minimum requirements for excessive algal growth (see Regional Overview). These values are much less than limits considered excessive for drinking water. While many of the assessments made in Figure ES1 are subjective, they are strongly based upon existing data and constitute a genuine attempt to portray the water quality within the Dallas-Fort Worth 208 Area.

PRESENTATION AREA	DRAINAGE AREA	Point Source Discharge	Texas Water Quality Standards (TWQB, 1976) Desirable Water Uses Contact Recreation	Noncontact Recreation	Propagation of Fish and Wildlife	Domestic Raw Water Supply	Criteria Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen	pH	Fecal Coliform	Temperature	OTHER WATER QUALITY INDICATORS Chemical-Physical Nutrients	Pesticides	Metals	[illegible]	Sediment	Biological Algae	Aquatic Vegetation	Macroinvertebrates
A	Lake Worth	+	+	+	+	+	⧅	⧅	⧅	⧅	⧅	◹	⧅	◥					⧅	◣	◺
	Lake Worth Headwaters	−	+	+	+	+	◹	◹	◹	◹	◹	◹	◹	◥							
	Lake Arlington	+	+	+	+	+	◹	◹	◹	◹	◹	◹	◹	◥					◣	◺	◥
	Lake Benbrook	+	+	+	+	+	⧅	⧅	⧅	⧅	⧅	⧅	⧅							◹	
B	Lake Lewisville	+	+	+	+	+	⬕	◹	◹	◹	◹	◹	◹	◥			⬕			⧅	
	Grapevine Lake	+	+	+	+	+	◹	◹	◹	◹	◹	◹	◹								
C	Elm Fork	+	+	+	+	+	⬕	⧅	⧅	⧅	⧅	◥	⧅	◥			⧅		■		
	Denton Creek	−	+	+	+	+	⧅	◹	◹	◹	⧅	◹	◹	◥					■		
D	Lake Ray Hubbard	+	+	+	+	+	◹	◹	◹	◹	◥	◹	◹	◥			◥		◣		
	Lake Lavon	+	+	+	+	+	⧅	⧅	⧅	⧅	⧅	⧅	⧅	◥			■		◣		
E	East Fork	+	−	+	+	+	⧅	⧅	⧅	■	⧅	◥	⧅	■		◹	⬔				
F	West Fork - BEACH ST. TO ELM FORK	+	−	+	+	−	◹	◹	◹	■	◹	⬕	◹	■		◹	⧅				
	West Fork - IN FORT WORTH	+	+	+	+	+	⧅	◹	◹	⧅	⧅	◥	⧅	■			■				
	Clear Fork	+	+	+	+	+	⧅	◹	◹	⧅	⧅	◹	⧅	◥							
G	Trinity River - ELM FORK TO ROSSER	+	−	+	+	−	⧅	⧅	⧅	■	⧅	■	⧅	■	◹	◹	■	■	◣		◣
	White Rock Lake	+	+	+	+	+	◹	◹	◹	◥	◹	◹	◹	◥							

+ YES
− NO
◹ RECENT DATA INDICATE FAVORABLE CONDITIONS
◺ HISTORICAL DATA INDICATE FAVORABLE CONDITIONS
⧅ BOTH RECENT AND HISTORICAL DATA INDICATE FAVORABLE CONDITIONS
◥ FOR TWQB STANDARDS, RECENT DATA INDICATE VIOLATIONS
◥ FOR OTHER WATER QUALITY INDICATORS, RECENT DATA INDICATE POTENTIAL PROBLEMS
◣ FOR TWQB STANDARDS, HISTORICAL DATA INDICATE VIOLATIONS
◣ FOR OTHER WATER QUALITY INDICATORS, HISTORICAL DATA INDICATE POTENTIAL PROBLEMS
■ FOR TWQB STANDARDS, BOTH RECENT AND HISTORICAL DATA INDICATE VIOLATIONS
■ FOR OTHER WATER QUALITY INDICATORS, BOTH RECENT AND HISTORICAL DATA INDICATE POTENTIAL PROBLEMS
(BLANK) DATA UNAVAILABLE OR INSUFFICIENT TO MAKE JUDGEMENT

SYNOPSIS OF EXISTING DATA FOR THE VARIOUS PRESENTATION AREAS WITHIN THE DALLAS-FORT WORTH 208 AREA

FIGURE ES1

REGIONAL OVERVIEW

REGIONAL OVERVIEW

HISTORICAL WATER QUALITY AND TRENDS

Historical data, where available, seem to indicate few significant changes in the various Presentation Areas. The most evident alterations, in many cases, appear to have taken place in the biological community, particularly in phytoplankton and fishes. However, different sampling methods employed over the years tend to confound detailed analysis.

Chemical water quality parameters, such as suspended and dissolved solids, nitrate, phosphate, and other mineral ions, while serving to indicate the overall quality of a body of water, tend to be greatly influenced by the amount of flow. This poses less of a problem in analyzing water quality trends in lakes than it does in more lotic environments.

Major nutrient concentrations in many of the area's bodies of water were considered excessive and conducive to the eutrophic symptoms exhibited. Levels of nitrogen and phosphorus encountered were, by and large, greater than those necessary to support large phytoplankton populations. For example Chu (1943), as cited in Hutchinson (1975), lists limiting levels of phosphate-phosphorus for lakes in the range of 0.02-0.089 mg/l. Chu (1942) and Sawyer, et al. (1945), both as cited in SWQCB (1967), and EPA (1973) report limiting levels of inorganic phosphorus and inorganic nitrogen for lakes of 0.015-0.05 mg/l and 0.2-0.3 mg/l respectively. EPA (1973) reports that for streams 0.100 mg/l phosphate-phosphorus is considered limiting to aquatic plants. These figures represent concentrations above which algal blooms might be expected to occur. It should be pointed out, however, that other factors are involved and these limits point only to potential problems. Also, these limits in no way refer to, and in fact are well within, standards set for drinking water (see EPA Safe Drinking Water Act).

The major lakes in the Dallas-Fort Worth 208 Area are Arlington, Benbrook, Grapevine, Lavon, Lewisville (Garza-Little Elm), Ray Hubbard, White Rock, and Worth. Chemical water analyses for approximately 15 years were available for several lakes, including Benbrook, Lavon, and Worth. Water quality indicated no change over this time period for Benbrook Lake or Lake Lavon. Lake Worth, on the other hand, reveals slightly increasing trends in chloride and sulfate concentrations, although both remain well within their respective TWQB (1976a) standards. Fewer data were encountered for the remaining lakes, but available data seemed to indicate fairly consistent water quality for the respective periods of record. In Lake Arlington, nitrate ion concentration shows an apparent increase over the period 1973-1976. The reason for this increase is not totally clear.

Several lakes, such as Arlington, Ray Hubbard, Lavon, and Lewisville, have sufficient data to reveal what appears to be a recent worsening of phytoplankton conditions. About 1971-1972, total phytoplankton cell counts at the Lake Lewisville outlet structure began showing large increases, particularly during early autumn. By 1976, these high concentrations had become almost constant. Similar occurrences, with resultant taste and odor problems, have taken place in Lakes Arlington, Lavon, and Ray Hubbard. Lake Arlington has experienced problems with phytoplankton virtually since impoundment was complete in 1957.

No lakes, except possibly Lake Worth, seem to have developed problems with aquatic macrophytes. TPWD (1970) reported that pondweed (Potamogeton sp.) and cattail (Typha sp.) were becoming problems in Lake Worth.

The fish communities show perhaps the greatest succession of all parameters. In particular, Lakes Benbrook and Worth exhibited apparent dramatic shifts from predominantly game fish communities to rough fish communities from the 1950's to the 1970's. Many factors, including predation, parasitism, overcrowding, preferential capture by fishermen, and insufficient restocking, may be responsible for these trends. It should be noted, however, that a shift toward rough fish is a natural condition.

Historical data on the various tributaries and sediments within each Presentation Area were generally insufficient to discuss trends in either chemical-physical parameters or biological parameters.

Data on the various stream segments within the Dallas-Fort Worth 208 Area revealed few clear trends, due largely to the effect of variable flows upon the concentrations of many parameters. Sufficient data were available, however, for analyses utilizing annual flow-weighted and time-weighted mean data for the main stem of the Trinity River (Segment 0805). No clear trends could be detected, and the effect of variable flows was still pronounced.

The West Fork, the main stem, and the East Fork of the Trinity River all had poor quality water, while the Clear Fork and Denton Creek had relatively clean water. Chemical parameters have shown no clear trends with the possible exception of the Elm Fork. During 1956 and 1957, concentrations of chloride, total alkalinity, and total hardness were unusually high in the Elm Fork due to pumping in water from the Red River for drinking water supplies. Since that time, the concentrations of these parameters have stabilized at much lower levels.

Biological data, with the possible exception of coliform bacteria and phytoplankton data, have been insufficient for trend analyses of the various Presentation Areas. Phytoplankton concentrations in the Elm Fork and Denton Creek began showing apparent marked increases around 1971-1972, similar to that exhibited by counts at the Lake Lewisville outlet works. Fecal coliform concentrations for the main stem of the Trinity River at SH 34 near Rosser have been apparently suppressed after the initiation of wastewater chlorination by the City of Dallas and the City of Fort Worth, but occasional high values continue to occur.

NONPOINT VS. POINT SOURCE LOADINGS

RESERVOIR PRESENTATION AREAS

The growth of both population and economic activity has brought reservoirs into existence for water supply in the Dallas-Fort Worth Metroplex Area. This continuous growth has caused more reservoirs to be built in order to assure that water demands are met adequately. There are eight reservoir segments and six free-flowing stream segments in existence in the Dallas-Fort Worth 208 Area. Reservoir segments include Lake Worth, Lake Arlington, Benbrook Lake, Lake Lewisville, Grapevine Lake, Lake Ray Hubbard, Lake Lavon, and White Rock Lake; stream segments include the Elm Fork from Lewisville Dam to the confluence with the Trinity River, Denton Creek, the East Fork from Ray Hubbard Dam to the confluence with the Trinity River, the Clear Fork from Benbrook Dam to the confluence with the Trinity River, the West Fork from Lake Worth Dam to Beach Street, and the West Fork from Beach Street to SH 34 near Rosser.

During the summer, every reservoir experiences a considerable amount of hypolimnetic oxygen depletion. Available data reveal that nutrients, nitrogen in particular, exist in all reservoirs in amounts greater than the critical level for the production of algal blooms.

These critical levels for inorganic nitrogen and phosphorus in lakes are about 0.1 mg/l and 0.2 mg/l respectively (Chu 1942, 1943; Sawyer, _et al_. 1945; and EPA 1973). It is evident that all reservoirs in the Dallas-Fort Worth 208 Area are in a eutrophic state. With the relatively high concentrations of nutrients present, a potential exists for further degradation of the reservoirs through the excessive development of nuisance (i.e., taste and odor-producing) algae. The addition of point and nonpoint source pollutants from upstream watersheds is largely responsible for the high nutrient levels in each reservoir. The point source pollution is from sewage treatment plants, and the nonpoint source pollution is primarily from rural and suburban runoffs, feedlots, septic tanks, and shoreline development. Lake Worth, Lake Arlington, Lake Lewisville, White Rock Lake, and Lake Ray Hubbard all have a substantial amount of shoreline development. Also, each has a significant algal community much of the year. Chemical and nutrient data are available for showing the overall water quality of each reservoir. However, data are insufficient for doing nutrient flux and budget calculations through the various reservoirs. Data are also inadequate for assessing the total nonpoint source contributions and for identifying each nonpoint source input for the various lake segments.

Due to the complexity of reservoir assimilative capacity and reservoir operations, nutrient budgeting seems to be beyond the scope of this study. However, a magnitude assessment between point and nonpoint source pollution of sediments, organic loading, nutrients, and toxic chemicals (pesticides and heavy metals) will provide some clues in formulating water quality and watershed management programs. These programs are essentially important for economic and safe water uses downstream.

STREAM PRESENTATION AREAS

Reservoir construction and continual urbanization have changed the river hydrology of free-flowing stream segments. There are six designated stream segments in the Dallas-Fort Worth 208 Area, which generally are made up of eutrophic water. Streamflows are generally comprised of large proportions of sewage return flows and seepage from reservoirs. Hence, poor quality streams appear in a number of segments. Frequently, this reflects sewage effluent characteristics, with high concentrations of nutrients and oxygen-depleting substances, low dissolved oxygen, and high turbidity, as well as sludge accumulation. This is particularly true for Segment 0805 (the West Fork and Main Stem Trinity River from Beach Street to SH 34 near Rosser) and Segment 0819 (East Fork from Ray Hubbard Dam to the confluence with the Trinty River).

Segment 0825 (Denton Creek) and Segment 0822 (the Elm Fork), which deliver water to the City of Dallas for water supplies, contain moderate amounts of flow with relatively good water quality. In fact, this quality is sensitive to reservoir releases from both Lake Lewisville and Grapevine Lake.

The last two stream segments are Segment 0806 (the West Fork from Lake Worth Dam to Beach Street) and Segment 0829 (the Clear Fork from Benbrook Dam to the confluence with the West Fork). Because these two segments are immediately below reservoir segments and receive virtually no sewage treatment plant discharges, the stream quality is generally good.

All of the stream segments are composed of mature streams with wide floodplains. Natural stream velocity is about one foot per second for most reaches. However, it may vary considerably depending upon the location and the volume of water. Because all of the stream segments are highly influenced by reservoir releases, point source effects can best be assessed during a drought period (i.e., when reservoir releases are at a minimum). Nonpoint sources, which are associated with runoff, reservoir releases for flood control purposes, and sludge resuspension can only be evaluated during a wet, high flow period. The wet period in the Metroplex area does not follow any specific wet-dry cycle on an annual basis, and the high flow or flood period may occur at any time of the year. However, substantial rainfall is somewhat more likely to occur in the spring.

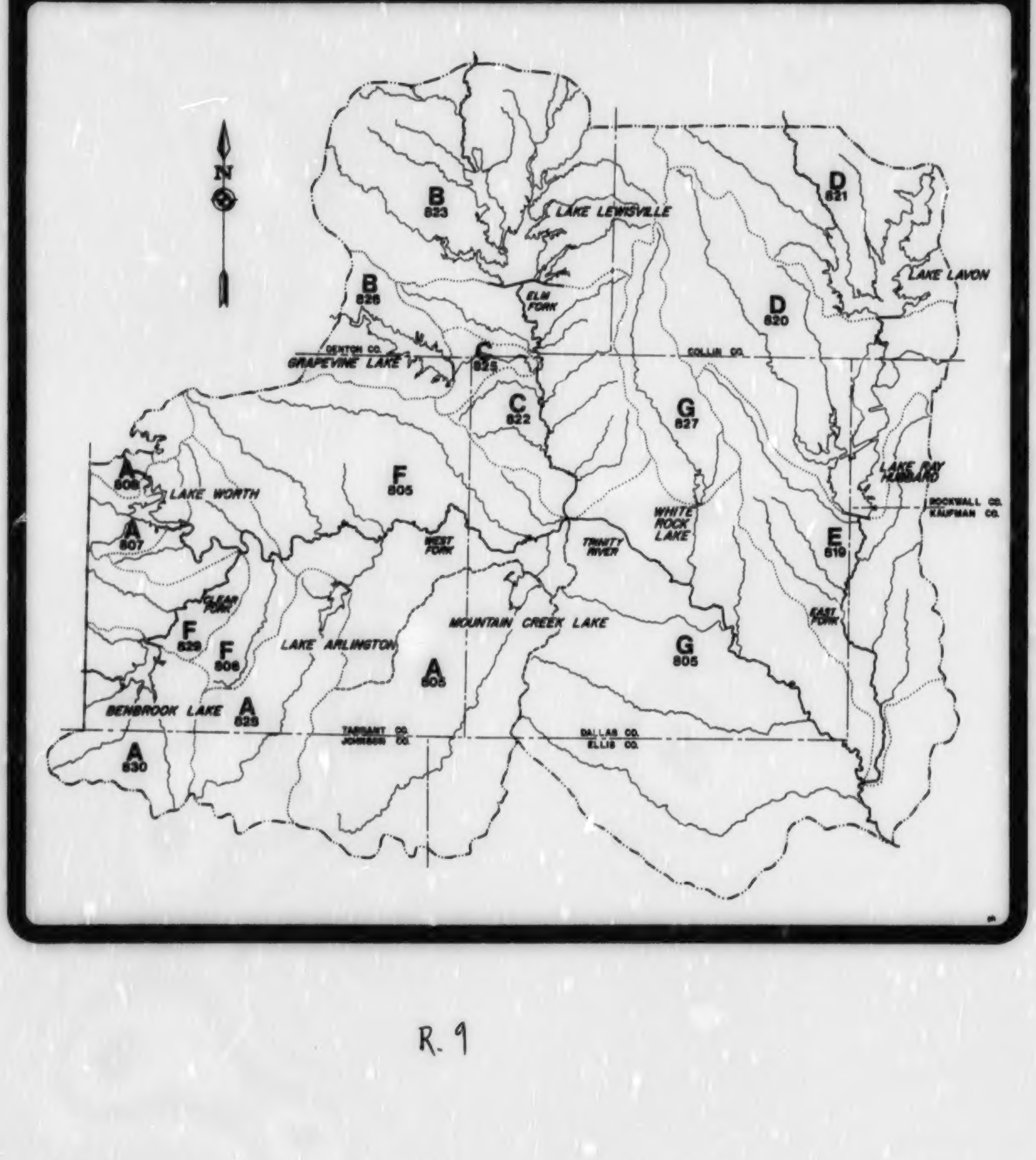
At present, few data are available for assessing nonpoint source pollution and its impact on water quality in streams in the Dallas-Fort Worth 208 Area. There exist only a few sets of data on total suspended solids and phosphorus which cover the entire event of a rainfall period in Segment 0805 (Trinity River Main Stem). Analysis of these preliminary data reveal that nonpoint sources during a high flow event can contribute phosphorus in a significant amount, ranging from 0.3 to 1.3 times the point source contribution. Data also indicate that total suspended solids from nonpoint source contribution can be 900 times greater than that of point source.

It appears that initial suburban development may constitute a significant nonpoint source of pollution within the study area. Other sources of nonpoint source pollution are urban (developed) and rural runoffs, reservoir releases, sludge resuspension, and groundwater seepage. Bottom sludge accumulations under low flow conditions and subsequent resuspension and flushing by flooding have made the study of nonpoint source pollution complex.

PRESENTATION AREAS

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B 823
LAKE LEWISVILLE
D 821
LAKE LAVON
B 826
ELM FORK
D 820
DENTON CO.
GRAPEVINE LAKE
C 825
COLLIN CO.
C 822
G 827
A 808
LAKE WORTH
F 805
LAKE RAY HUBBARD
ROCKWALL CO.
KAUFMAN CO.
A 807
WEST FORK
TRINITY RIVER
WHITE ROCK LAKE
E 819
CLEAR FORK
MOUNTAIN CREEK LAKE
EAST FORK
F 829
F 806
LAKE ARLINGTON
A 805
G 805
BENBROOK LAKE
A 828
TARRANT CO.
JOHNSON CO.
DALLAS CO.
ELLIS CO.
A 830

PRESENTATION AREAS

The following is a synoptic compilation of existing and available data for the seven Presentation Areas (A-G) within the Dallas-Fort Worth 208 Area. The Presentation Area concept groups similar bodies of water, largely for comparative purposes. Data presented herein fell into two main categories, Chemical-Physical and Biological, and two time frames, Recent (10-1-74 through 6-30-76) and Historical (prior to 10-1-74). Under the Chemical-Physical heading come the subheadings Water Analyses, Tributary Water Analyses, and Sediment Analyses. Under Biological, come the subheadings Bacteria, Plankton, Aquatic Vegetation, Macroinvertebrates, and Fishes. Again, data within all of the above headings and subheadings have been analyzed for both recent and historical periods.

The recent Water Analyses table provides the most comprehensive presentation of available data. Data computations for the various parameters are presented as the mean, maximum, and minumum values, as well as the standard deviation (s) and the number of observations (n). The majority of the data for use in the aforementioned table came from various agencies' monitoring programs. This is designated by the agency's abbreviation, followed by the stations sampled. Occasionally non-monitoring data were utilized. In that case, the agency abbreviation appears, but no station numbers are included.

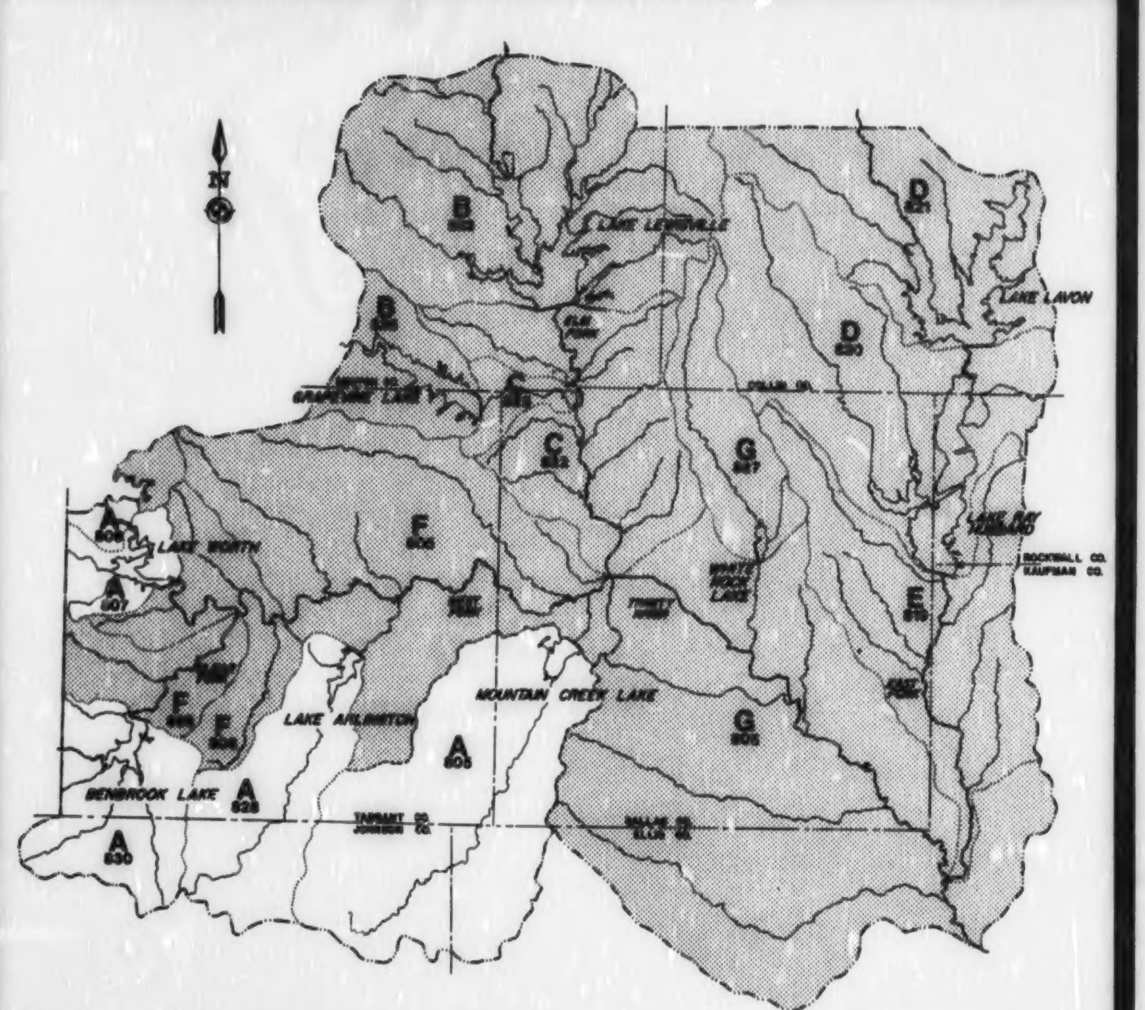
Appropriate data are compared to TWQB (1976a) standards. It should be pointed out that, in general, the criteria for lake segments differ from the criteria for stream segments. Also, the dissolved oxygen and fecal coliform criteria for Segment 0805 (the West Fork and Trinity River from Beach Street to SH 34 near Rosser) and Segment 0819 (the East Fork) are more lenient than for other segments in the area. This is due to the fact that these two segments are considered "inland effluent-dominated streams" by TWQB (1976a).

PRESENTATION AREA A

WEST FORK LAKES

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B
B
LAKE LEWISVILLE
ELM FORK
GRAPEVINE LAKE
C
C
D
D
LAKE LAVON
COLLIN CO.
G
LAKE RAY HUBBARD
ROCKWALL CO.
KAUFMAN CO.
WHITE ROCK LAKE
TRINITY RIVER
E
EAST FORK
A
A
LAKE WORTH
F
WEST FORK
F
F
LAKE ARLINGTON
MOUNTAIN CREEK LAKE
A
G
BENBROOK LAKE
A
TARRANT CO.
JOHNSON CO.
A
830
ELLIS CO.

PRESENTATION AREA A - WEST FORK LAKES

SUMMARY

All TWQB (1976a) water quality criteria were met by all of the West Fork lakes. Notwithstanding the fact that these four lakes are considerably different ages, water quality appears to be quite comparable among them.

All four lakes have high dissolved oxygen concentrations, moderate nutrient concentrations, low fecal coliform bacteria counts, and a total hardness in the range of 100-150 mg/l. This constitutes generally good water quality with some eutrophic symptoms indicated. All four lakes undergo substantial nutrient buildup and oxygen depletion in the hypolimnion during summer stratification.

Phytoplankton data, while generally unavailable for Benbrook Lake, indicated little problem in Lake Worth. Lake Arlington, on the other hand, has considerable difficulty with high algal counts. Taste and odor-producing algae have been common since the lake filled in 1957.

Based on available historical data, there has been little change in the water quality of these four lakes. However, the lakes have undergone an apparent, marked alteration in fish community structure, with increasing numbers and biomass of rough fish species reported. (Recent data unavailable for Mountain Creek Lake).

Figures A1, A6, A8, A13, and A18 show enlarged maps of Lake Worth, Lake Worth headwaters, Lake Arlington, Benbrook Lake, and Mountain Creek Lake respectively.

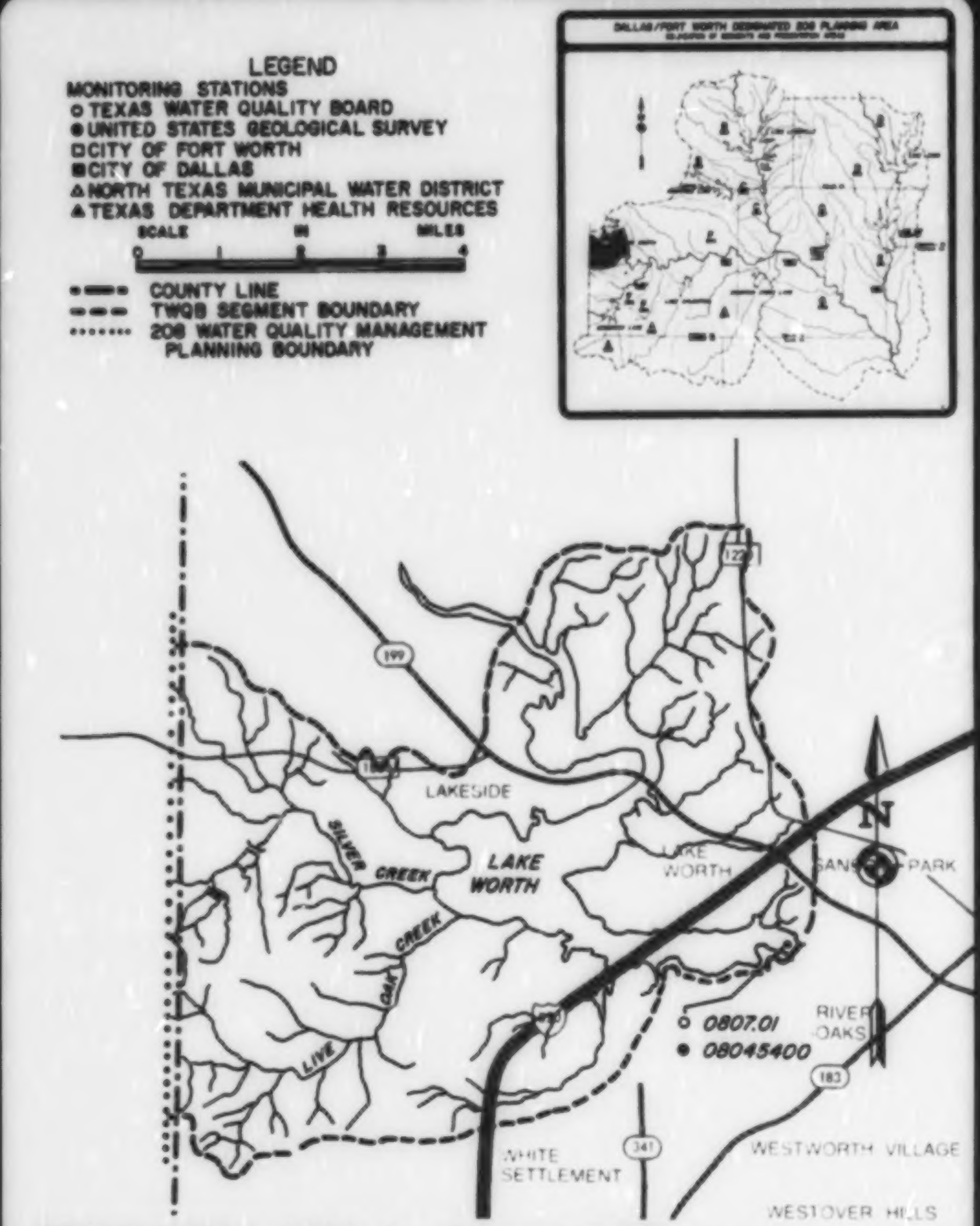
MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Lake Worth - Segment 0807			
TWQB	Lake Worth at midlake near dam	0807.01	CcBb
USGS	Lake Worth above Fort Worth	08045400	Qp
Lake Worth Headwaters - Segment 0808			
TWQB	Lake Worth at Ten Mile Bridge Road in Fort Worth	0808.01	Cc
Lake Arlington - Segment 0828			
TWQB	Lake Arlington at midlake near dam	0828.01	CcBbS
USGS	Lake Arlington at Arlington	08049200	RQpOp

continued. . .

Agency	Location	Station Number	Type of Record*
Benbrook Lake - Segment 0830			
TWQB	Benbrook Reservoir at midlake near dam	0830.01	Cc
USGS	Benbrook Lake near Benbrook	08046500	QpR
Mountain Creek Lake			
USGS	Mountain Creek near Cedar Hill	08049600	DdQpOp
USGS	Walnut Creek near Mansfield	08049700	Dd
USGS	Mountain Creek near Duncanville	08049900	GQpOp
USGS	Mountain Creek Lake near Grand Prairie	08050050	RQp

*The "Type of Record" designations for each Agency are explained under Appendix A, Sources of Information.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA
199
LAKESIDE
SILVER CREEK
LAKE WORTH
LIVE OAK CREEK
LAKE WORTH
SANSOM PARK
N
○ 0807.01
● 08045400
RIVER OAKS
183
341
WHITE SETTLEMENT
WESTWORTH VILLAGE
WESTOVER HILLS

PRESENTATION AREA A - Segment 0807

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE A1

LAKE WORTH - Segment 0807

Lake Worth was constructed during the period 1912 - 1914, and impoundment of water began in June 1914. Lake Worth has a drainage area of 5346 square kilometers (2064 square miles). The surface area of the reservoir is 14.4 square kilometers (3560 acres), and it has a volume of 4.70×10^7 cubic meters (38,130 acre-feet). Lake Worth first reached normal capacity in April 1915. Since that time, it has been used as a water supply reservoir for the City of Fort Worth. Water entering Lake Worth is almost exclusively releases from Eagle Mountain Lake, the water quality of which is quite good.

A map of Lake Worth is presented in Figure A1, showing existing monitoring stations.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Lake Worth (FW; TWQB 0807.01). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	19	28	8.0	7	16
Dissolved Oxygen	9.3	12	7.9	1.7	8
pH (pH units)	8.0	8.3	7.3	0.4	15
Conductivity (umhos/cm)	383	470	315	46	16
Turbidity (JTU)	11	24	4.9	7.8	7
Total Suspended Solids	17	37	8	**	9
Volatile Suspended Solids	6	16	3	**	9
Total Dissolved Solids	200	232	157	28	6
Total Solids	237	268	209	24	7
Ammonia, as N	0.06	0.16	0.00	**	8
Nitrate, as N	0.03	0.06	0.00	0.02	7
Total Phosphate, as P	0.14	0.23	0.00	**	7
Orthophosphate, as P	0.07	0.10	0.008	**	6
Chloride, as Cl	54	138	26	**	15
Sulfate, as SO_4	26	39	16	5	16
Total Alkalinity, as $CaCO_3$	127	145	117	-	5
Total Hardness, as $CaCO_3$	144	152	132	8	7
Carbonate, as CO_3	1	4	0	**	7
Bicarbonate, as HCO_3	162	173	147	10	7
Chlorophyll a (ug/l)	5	7	0	3	7
Secchi (cm)	70	152	30	**	6
Fecal Coliform (#/100 ml)	53*	940	4	**	6
Total Organic Carbon	11	20	3	-	4
Calcium, as Ca	47	50	44	3	7
Magnesium, as Mg	6	8	3	2	7
Silica, as SiO_2	4.69	6.00	2.04	1.29	7
Iron, as Fe	0.07	0.14	t	**	7

continued. . .

Parameter	Mean	Max	Min	S	N
Aluminum, as Al_2O_3	0.08	0.11	0.03	0.03	7
Sodium, as Na	35	44	29	5	7
Fluoride, as F	0.26	0.28	0.22	0.02	7

-Standard deviation not computed when N is less than six.
t trace amount
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Lake Worth were taken from TWQB (1976a).

Temperature - Not to exceed 32.8 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable range: 7.0 - 9.0. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met (no reported values in excess of 500 mg/l).
Chloride - Mean concentration not to exceed 100 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 100 mg/l. Criterion met (no reported values in excess of 100 mg/l).
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Water quality in Lake Worth appears to be fairly good. The dissolved oxygen appears to be consistently high, nutrients and chlorophyll a are relatively low, and fecal coliform organisms are fairly low in concentration. No problems with TWQB (1976a) standards were encountered. The water in Lake Worth is moderately hard to hard.

Figures A2 and A3 contain profiles for dissolved oxygen, temperature, and pH in Lake Worth for unstratified and stratified periods respectively. Lake Worth undergoes stratification during the summer. This is evidenced more by the change in dissolved oxygen concentrations than the change in temperature.

Tributary Water Analyses - Tributaries running into Lake Worth include Live Oak Creek, Silver Creek, and numerous small, unnamed tributaries. The West Fork Trinity River joining Lake Worth to Eagle Mountain Lake actually constitutes Lake Worth headwaters. This portion of the river is set aside as Segment 0808, and data on this portion of the river will be covered in the section on Segment 0808. No other data on tributaries running into Lake Worth were encountered.

Sediment Analyses - No recent data for sediment pollutants were encountered for Lake Worth.

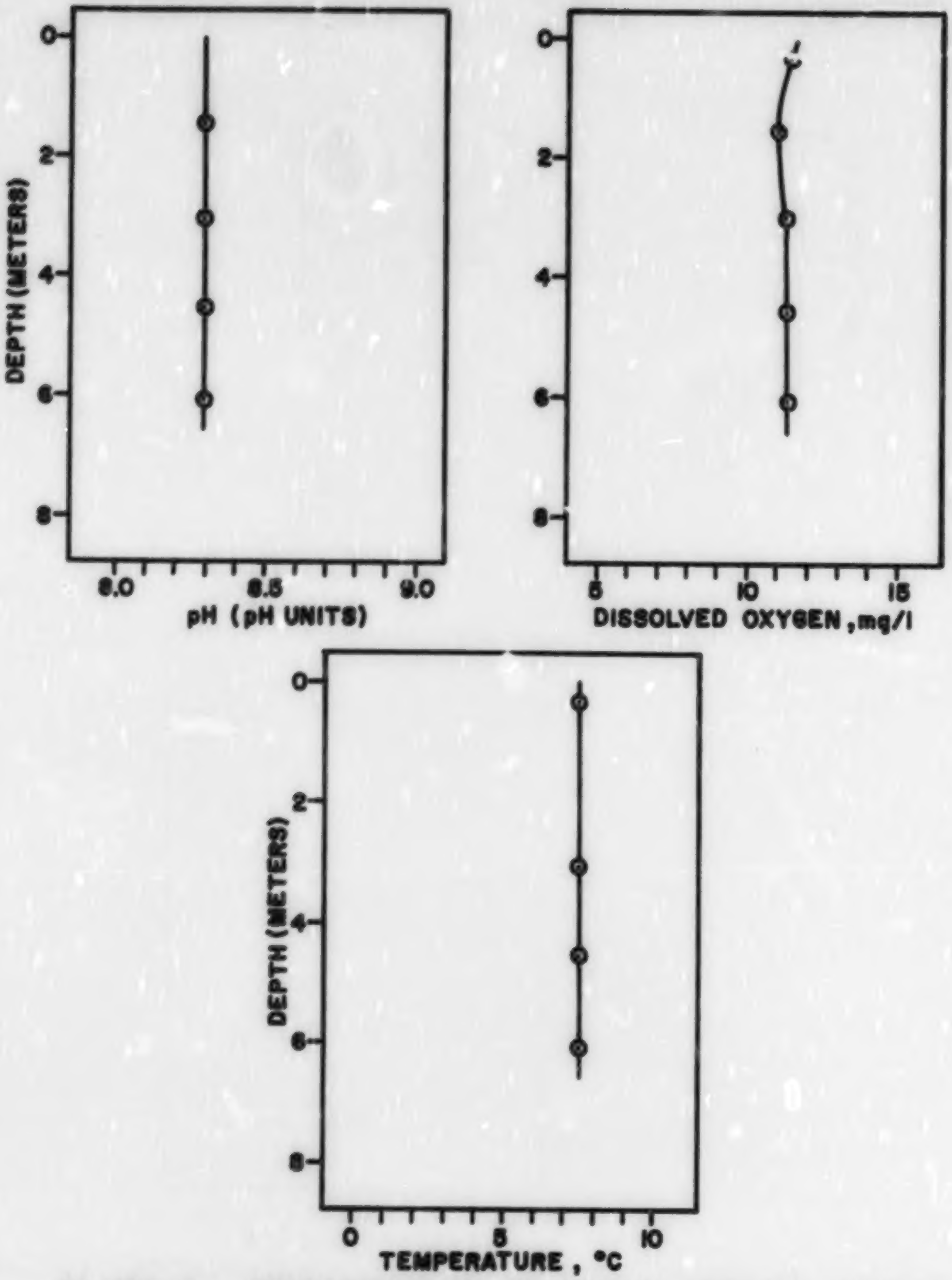


FIGURE A2. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN LAKE WORTH FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON JANUARY 21, 1976 (TIME 1430).

(DATA FROM TWQB 0807.01)

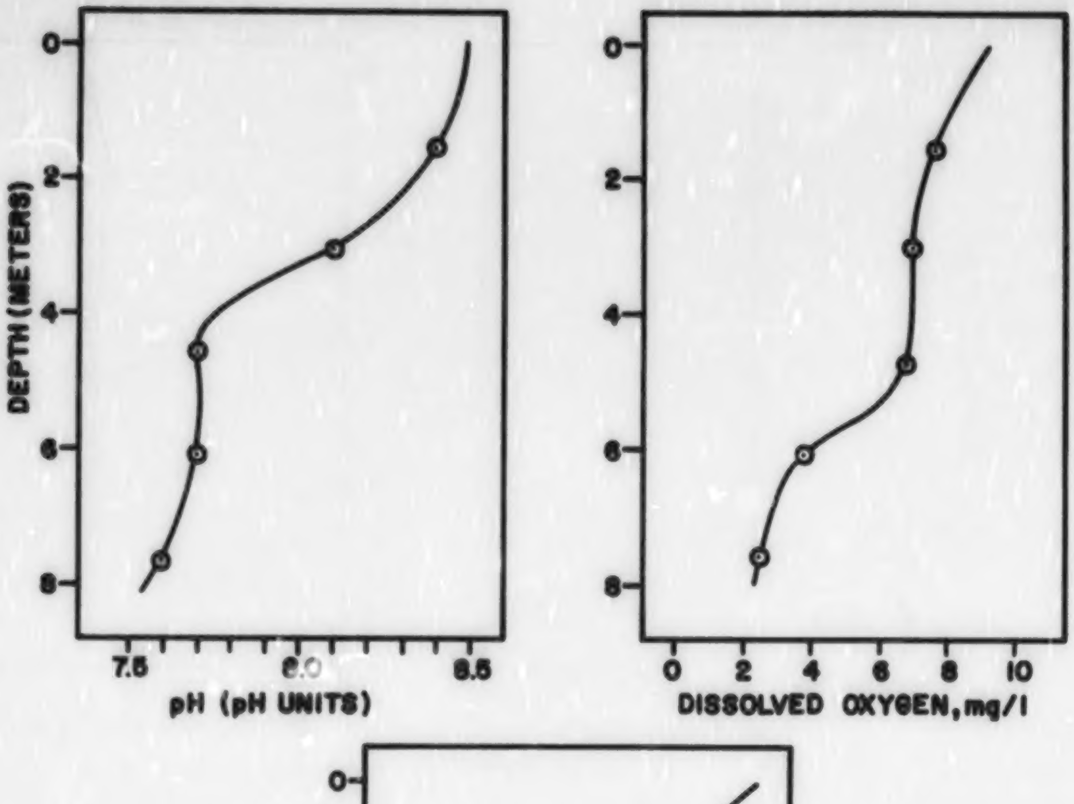


FIGURE A3. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN LAKE WORTH FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON JULY 28, 1975 (TIME 1115).
(DATA FROM TWQB 0807.01)

Biological
(10-1-74 through 6-30-76)

Bacteria - Recent bacteria data were summarized in the WATER ANALYSES table. Fecal coliform data produced a logarithmic mean of 53 organisms/ 100 ml, which is considerably less than the standard of 200 organisms/100 ml. The maximum fecal coliform value reported for the recent period was 940 organisms/100 ml.

No other recent bacteria data were encountered for Lake Worth.

Plankton - The City of Fort Worth (1962-1976) has conducted phytoplankton counts and generic identification on water samples from Lake Worth since 1962. The maximum cell count for the recent period was 798 total cells/ml, reported for June 1975. The minimum was 62 cells/ml, reported for December 1975.

Aquatic Vegetation - No recent surveys of aquatic macrophytes in Lake Worth were encountered.

Macroinvertebrates - No recent data on macroinvertebrates were encountered for Lake Worth.

Fishes - No recent fish survey data were encountered for Lake Worth. According to TPWD records, however, Lake Worth was stocked with 150,000 Florida Bass in 1975.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Very little apparent change has taken place in the quality of the water since 1962. The total hardness of the water has remained about 130-150 mg/l. The various minerals (calcium, magnesium, silica, etc.) have remained relatively constant during the same time period. Figure A4 presents historical trends for chloride, sulfate, and bicarbonate. These three parameters appear to show a slight increasing trend over the period 1962-1976. The mean nitrate-nitrogen concentration for the period 1961-1969 was 0.19 mg/l (n=34). The maximum reported value was 2.70 mg/l (Fort Worth data).

Tributary Water Analyses - No historical data were encountered for any of the tributaries entering Lake Worth.

Sediment Analyses - No historical analyses for sediment pollutants were encountered for Lake Worth.

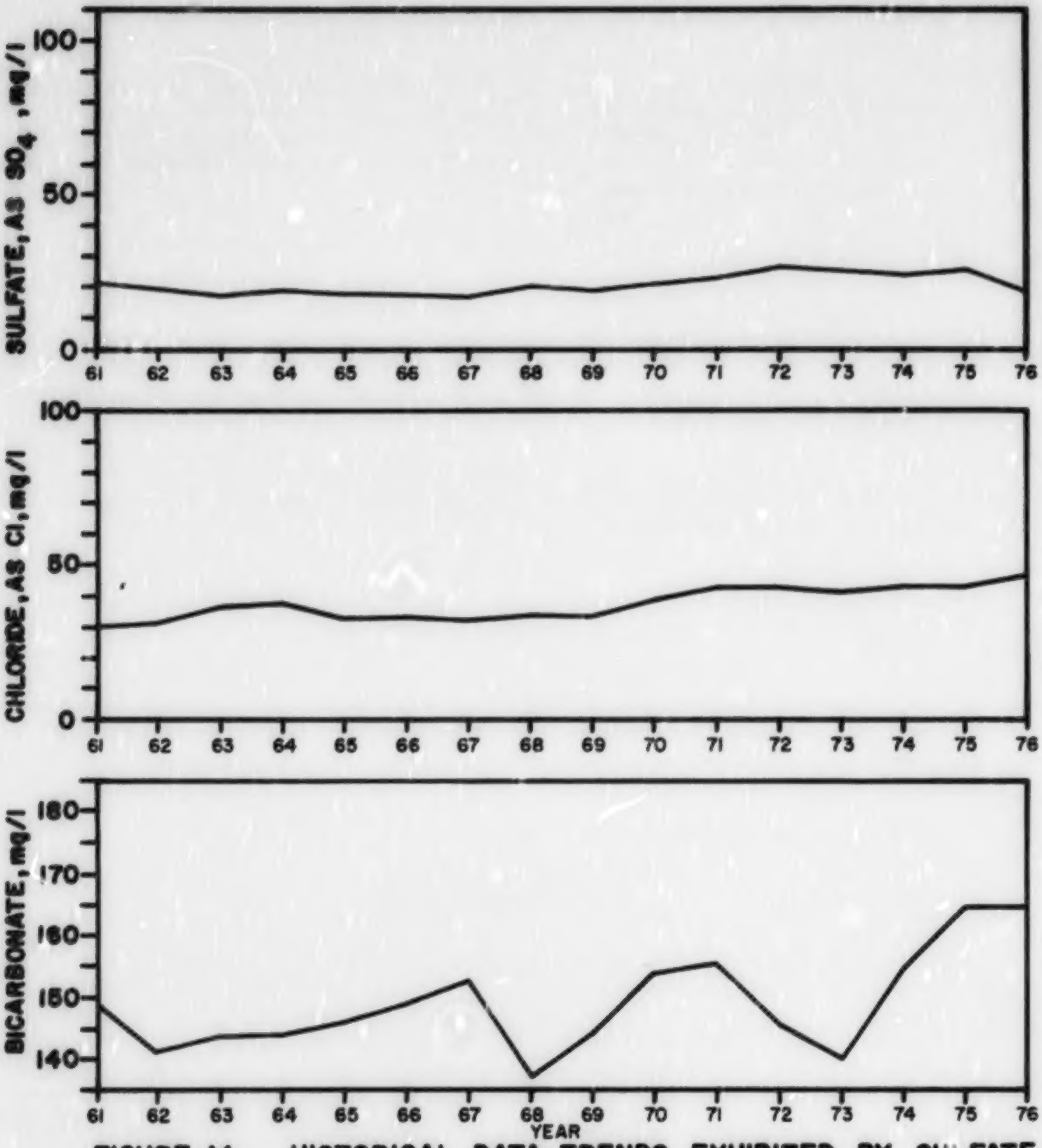


FIGURE A4. HISTORICAL DATA TRENDS EXHIBITED BY SULFATE, CHLORIDE, AND BICARBONATE AT LAKE WORTH (Segment 0807). VALUES PLOTTED ARE YEARLY MEANS. (DATA FROM CITY OF FORT WORTH 1949-1976)

Biological
(Prior to 10-1-74)

Bacteria - Fecal coliform data go back only to Water Year (WY) 1973, with only one value (58 organisms/100 ml) reported for WY 1973. Data for WY 1974 produce a log. mean 24 organisms/100 ml and a maximum of 240 organisms/100 ml.

Plankton - Historical phytoplankton counts are presented for the period 1962-1976 in Figure A5. Lake Worth appears to have had little problem with algae over this time period. One high concentration, 3188 cells/ml, was recorded for May 1969.

Johns (1939) found Lake Worth to have a higher number of phytoplankton than younger lakes in the area. He also stated that maximum phytoplankton production took place during the cooler part of the year.

Aquatic Vegetation - TPWD (1970) reported that aquatic vegetation was becoming a "problem" in Lake Worth. The macrophytes mentioned were cattail (*Typha* sp.) and pondweed (*Potamogeton* sp.), although a complete survey was not reported. No other historical data on aquatic macrophytes were encountered for Lake Worth.

Macroinvertebrates - Jenkins (1940) reported that a "large and rather varied population of bottom organisms" inhabited Lake Worth. The following table presents the most common organisms encountered by Jenkins (1940).

Lake Worth Benthic Macroinvertebrates
Segment 0807
(Taken From Jenkins 1940)

Shallow Water	*Deep Water*
a. Insecta	
Ephemerida	*Chaoborus* sp.
Ceratopogonidae	*Coelotanypus* sp.
Enallagma sp.	
Chaenis sp.	
Coelotanypus sp.	
b. Mollusca	
Quadrula sp.	
Lampsilis sp.	
c. Crustacea	
Cambarus sp.	
Mysis sp.	

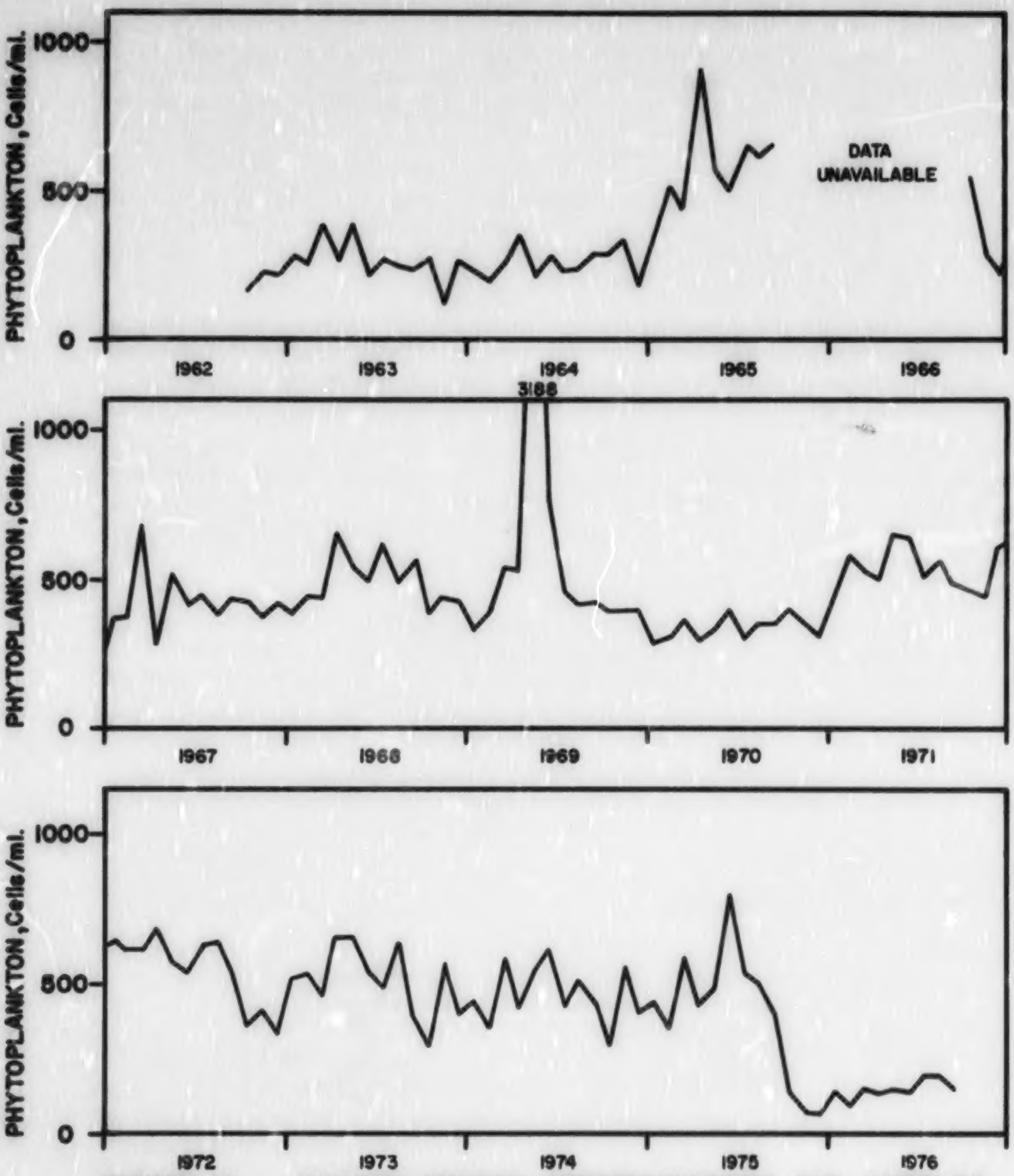


FIGURE A5. PHYTOPLANKTON CONCENTRATIONS FOR SAMPLES FROM LAKE WORTH (Segment 0807).
(DATA FROM CITY OF FORT WORTH 1962-1976)

Fishes - Table I presents historical trends in the Lake Worth fish community. By 1969, the percentage of rough fish (by biomass) appeared to have increased to over 86%. This was due mainly to increased numbers of longnose gar netted. In addition, game fish appear to show an increasing trend in both numbers and biomass. Interpretation of reported fish survey data is confounded by the fact that different methods (some experimental) are often introduced.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering Lake Worth. However, there exist one industrial and no domestic point sources within this segment, according to TWQB (1975-1976).

WATER USES

Domestic and Municipal

Lake Worth is heavily used for domestic and municipal water supplies. The primary user is the City of Fort Worth. Upstream waters are released from Eagle Mountain and Bridgeport reservoirs and flow into Lake Worth through the upper West Fork. All of the City of Fort Worth withdrawals from this system are made at Lake Worth and the estimated yield is 3.29 cubic meters per second (75.0 MGD) (NCTCOG 1974).

Industrial

There are no official permits issued authorizing the removal of water from Lake Worth for industrial purposes, according to NCTCOG (1974). However, some of the water removed for domestic and municipal use is utilized in local private industries.

Agricultural

According to NCTCOG (1974), the waters of Lake Worth are not used as an agricultural water supply.

Recreational

Lake Worth is heavily used as a source of local recreation. Activities occurring on the lake include boating, fishing, and swimming.

SUMMARY

Lake Worth revealed few, if any, problems with water quality. All of the TWQB (1976a) criteria were met. Vertical summer profiles revealed

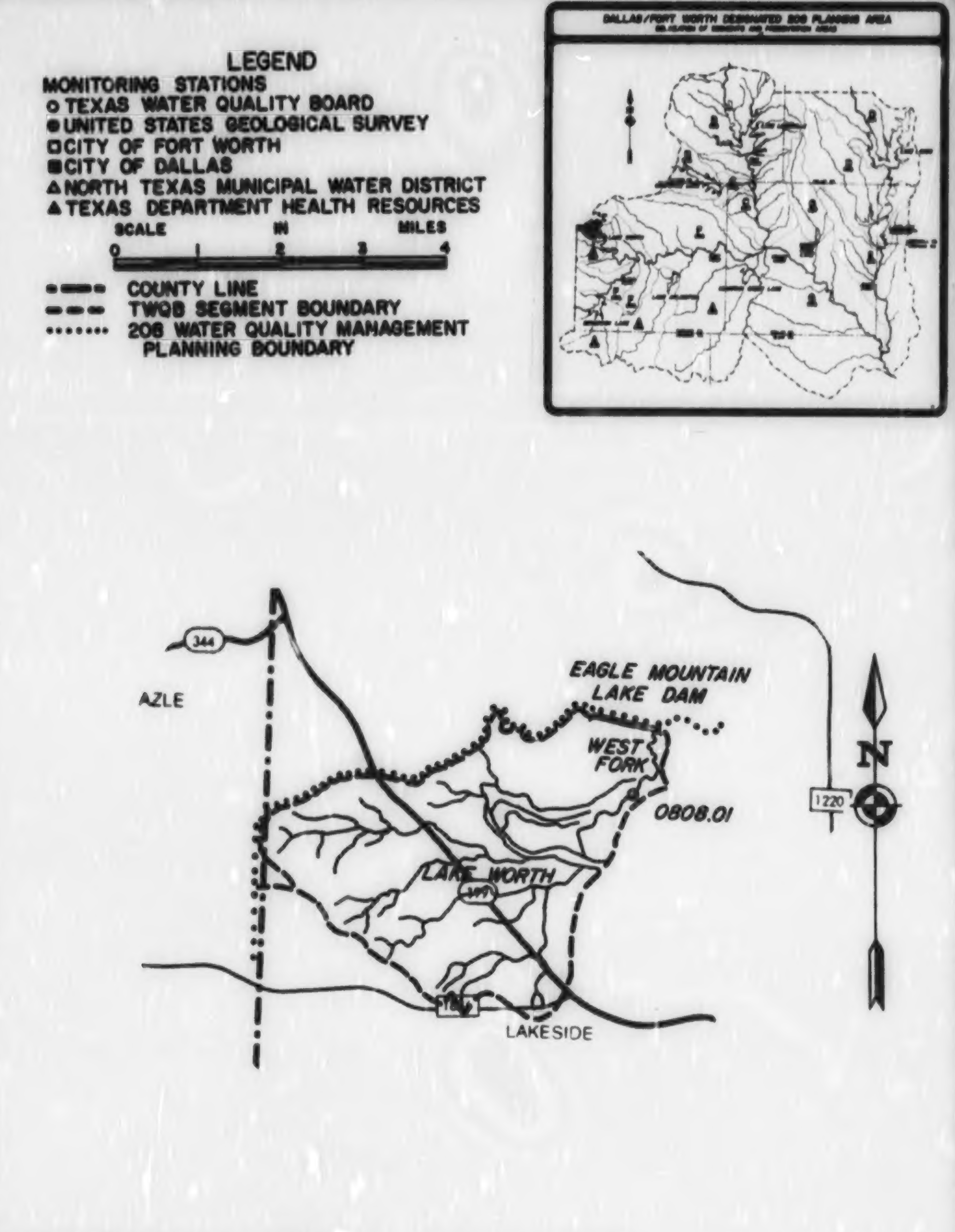
TABLE NO. I

TRENDS IN THE FISH COMMUNITY FOR LAKE WORTH (SEGMENT 0807)
(DATA FROM TPWD 1961, 1962, 1963, 1970)

	1958-1959				1960-1961				1961-1962				1969			
FISH	NO.	(%)	KG.	(%)	NO.	(%)	KG.	(%)	NO.	(%)	KG.	(%)	NO.	(%)	KG.	(%)
Rough Fish																
Spotted gar	1	(2.4)	0.5	(4.8)	1	(2.1)	0.8	(7.4)	3	(3.4)	2.1	(7.0)	4	(0.9)	2.1	(0.6)
Gizzard shad	2	(4.9)	0.3	(2.6)	20	(41.7)	2.9	(27.8)	8	(9.2)	1.3	(4.2)	38	(8.4)	5.8	(1.7)
Smallmouth buffalo	2	(4.9)	1.1	(10.9)					2	(2.3)	3.2	(10.3)	56	(12.4)	146.4	(42.2)
River carpsucker	3	(7.3)	1.4	(13.5)					8	(9.2)	6.3	(20.4)	14	(3.1)	17.8	(5.1)
Carp	2	(4.9)	1.2	(11.7)					2	(2.3)	1.2	(4.0)	18	(4.0)	41.1	(11.9)
Drum	2	(4.9)	0.5	(4.4)												
Longnose gar					1	(2.1)	3.2	(29.7)	1	(1.2)	1.4	(4.4)	58	(12.8)	83.1	(24.0)
Spotted sucker													6	(1.3)	3.1	(0.9)
Rough Fish Totals	12	(29.3)	5.0	(47.9)	22	(45.9)	6.9	(64.9)	24	(27.6)	15.5	(50.3)	194	(42.9)	299.4	(86.4)
Game Fish																
Channel catfish	3	(7.3)	0.7	(7.0)	3	(6.2)	0.6	(5.7)	4	(4.6)	1.7	(5.4)	13	(2.9)	11.5	(3.3)
White crappie	4	(9.8)	0.9	(8.3)	15	(31.3)	2.0	(18.8)	42	(48.3)	9.3	(30.1)	111	(24.6)	18.0	(5.2)
Bluegill sunfish	15	(36.6)	1.8	(17.0)	6	(12.5)	0.6	(5.7)	3	(3.4)	0.4	(1.3)	42	(9.3)	3.9	(1.1)
Redear sunfish	1	(2.4)	0.1	(0.9)									2	(0.4)	0.2	(0.03)
White bass	1	(2.4)	0.2	(1.74)	1	(2.1)	0.2	(2.1)	11	(12.6)	3.0	(9.8)	71	(15.7)	8.0	(2.3)
Largemouth bass	5	(12.2)	1.8	(17.4)	1	(2.1)	0.3	(2.8)	3	(3.4)	1.0	(3.1)	16	(3.5)	3.4	(1.0)
Black bullhead													1	(0.2)	0.2	(0.05)
Flathead catfish													1	(0.2)	2.4	(0.7)
Green sunfish													1	(0.2)	0.05	(0.02)
Game Fish Totals	29	(70.7)	5.5	(52.3)	26	(54.2)	3.7	(35.1)	63	(72.3)	15.4	(43.7)	258	(57.0)	47.6	(13.7)
TOTALS	41	(100.0)	10.5	(100.2)	48	(100.1)	10.6	(100.0)	87	(99.9)	30.9	(100.0)	452	(99.9)	347.0	(100.1)

stratification patterns less severe than other reservoirs in the Dallas-Fort Worth 208 area. Water quality data on tributaries, as well as sediment data, were almost entirely lacking.

Some biological data existed, indicating some past "problems" with both aquatic vegetation and fishes, although recent data for both were lacking.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA
344
AZLE
EAGLE MOUNTAIN LAKE DAM
WEST FORK
0808.01
N
1220
LAKE WORTH
LAKESIDE

PRESENTATION AREA A - Segment 0808

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE A6

WEST FORK TRINITY RIVER, LAKE WORTH HEADWATERS TO EAGLE MOUNTAIN DAM - Segment 0808

Water quality in this segment is dependent on releases from Eagle Mountain Lake. There are no direct point source discharges of domestic and municipal wastewater into Segment 0808. Data indicate no water quality problems in this segment.

A map of the Lake Worth headwaters is shown in Figure A6, pinpointing existing monitoring stations.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Lake Worth headwaters (TWQB 0808.01). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	14.3	26.0	7.8	6.2	10
Dissolved Oxygen	10.7	12.9	7.4	1.5	10
pH (pH units)	7.8	8.3	7.3	0.3	10
Conductivity (umhos/cm)	366	500	180	109	10
Total Suspended Solids	51	202	5	-	5
Volatile Suspended Solids	2	8	0	-	5
Total Dissolved Solids	183	250	90	54	10
Ammonia, as N	0.08	0.10	0.03	-	5
Nitrate, as N	0.13	0.225	0.03	-	5
Total Phosphate, as P	0.16	0.33	0.05	-	5
Orthophosphate, as P	0.09	0.17	0.02	-	5
Chloride, as Cl	50	67	36	-	5
Sulfate, as SO_4	55	191	16	-	5
Fecal Coliform (#/100 ml)	24*	105	10	-	4
Chlorophyll a (ug/l)	6	12	4	-	5
Total Organic Carbon	12	19	4	-	2
Turbidity (JTU)	18	45	0	**	6

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in the Lake Worth headwaters were taken from TWQB (1976a).

Temperature - Not to exceed 32.8 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable range: 6.5 - 8.5. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met.

Chloride - Mean concentration not to exceed 100 mg/l. Criterion met.

Sulfate - Mean concentration not to exceed 100 mg/l. Criterion met (one value out of five exceeded 100 mg/l).

Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Tributary Water Analyses - No data on tributaries running into the Lake Worth headwaters (Segment 0808) were encountered.

Sediment Analyses - No data were encountered for sediment pollutants in the Lake Worth headwaters.

Biological
(10-1-74 through 6-30-76)

Bacteria - Fecal coliform data reported by the TWQB have a log. mean of 24 organisms/100 ml. This value is considerably below the TWQB (1976a) standard for Segment 0808 of 200 organisms/100 ml, but only four values were reported for the recent period. The maximum value reported was 105 organisms/100 ml for the recent period. No other recent bacteria data were encountered.

No other recent data on biological parameters for Lake Worth headwaters were encountered.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - For the historical data available, the water quality in Segment 0808 appears to have remained good over the past several years. Figure A7 graphs mean values for dissolved oxygen, pH, conductivity, fecal coliform, and chlorophyll a for the period 1973-1976. Dissolved oxygen is consistently high, and perhaps showing an increasing trend. A possible decreasing trend may be exhibited by pH. The other parameters show no clear trend. Water quality in this reach is greatly subject to the quality of releases from Eagle Mountain Lake. This is apparently good and results in continually high dissolved oxygen values.

Tributary Water Analyses - No historical data on tributaries were encountered for the Lake Worth headwaters.

Sediment Analyses - No historical sediment pollutant analyses were encountered for Segment 0808.

Biological
(Prior to 10-1-74)

Bacteria - Available historical fecal coliform data are summarized in Figure A7. No data were reported by the TWQB prior to September 6, 1973. The mean value of 371 organisms/100 ml for 1973 is for a partial year and is an arithmetic mean. The log. mean for the same data (four data points) is only 143 organisms/100 ml. This is well below the TWQB (1976a) standard of 200 organisms/100 ml. No other historical bacteria data were encountered for the Lake Worth headwaters.

No other historical biological data were encountered for Segment 0808.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering the West Fork Trinity River, Lake Worth headwaters to Eagle Mountain Dam. However, there are no point source discharges into this segment, according to TWQB (1975-1976).

WATER USES

Water uses in the Lake Worth headwaters are discussed in the WATER USES section of Lake Worth (Segment 0807).

SUMMARY

Available water quality data for the Lake Worth headwaters revealed no problems. All of the TWQB (1976a) criteria were met. No data, either recent or historical, were available for tributaries or sediment within this reach. Biological data were limited to bacteria analyses conducted for several years. The Lake Worth headwaters receive no point source discharges, and water quality appears to be quite good.

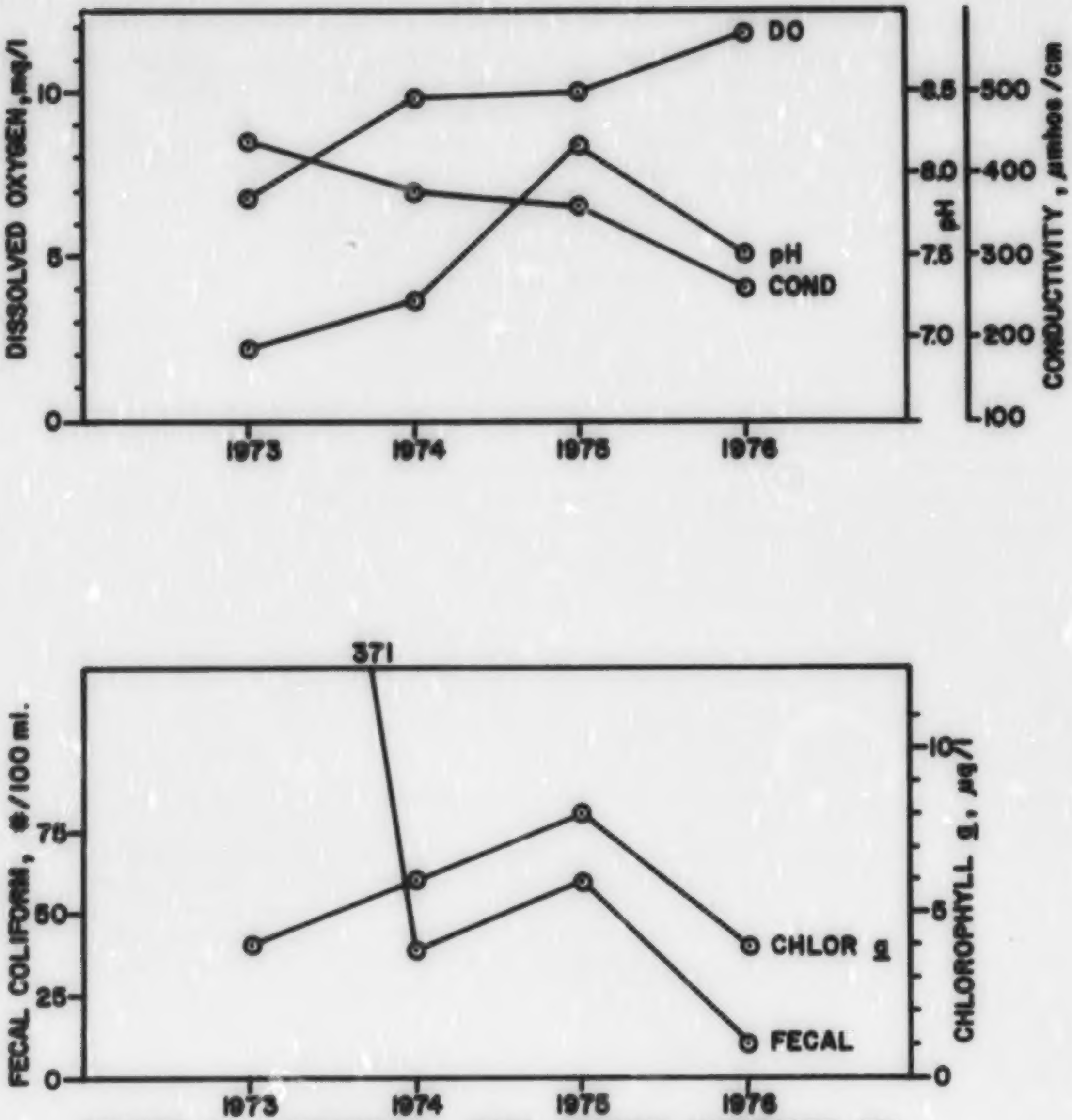
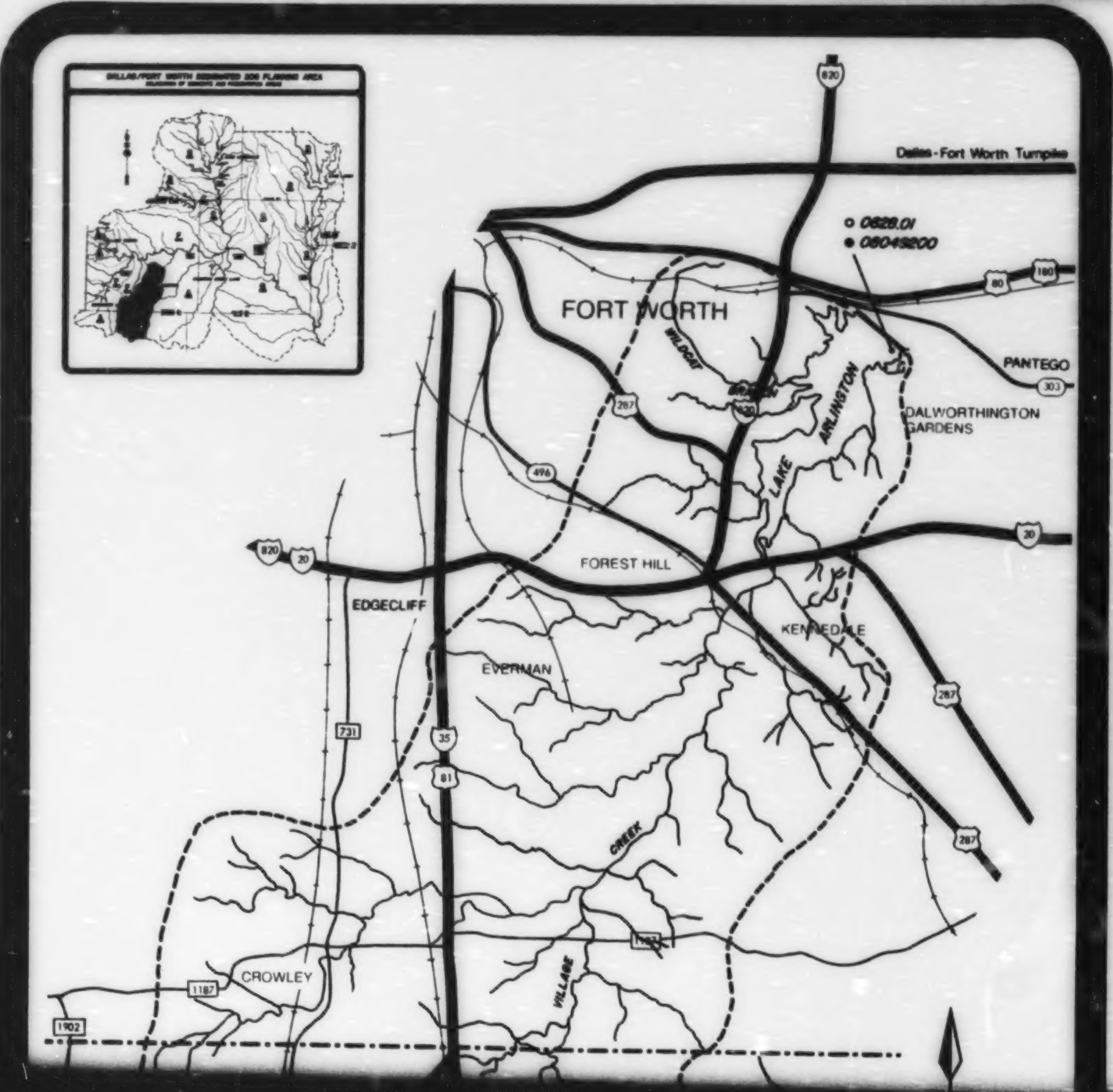


FIGURE A7. HISTORICAL DATA TRENDS EXHIBITED BY DISSOLVED OXYGEN, pH, CONDUCTIVITY, FECAL COLIFORM, AND CHLOROPHYLL a FOR THE LAKE WORTH HEADWATERS (Segment 0808).

(DATA FROM TWQB 1972-1976)


Dallas-Fort Worth Turnpike
○ 0828.01
● 08049200
FORT WORTH
WILDCAT
BRANCH
PANTEGO
DALWORTHINGTON
GARDENS
LAKE
ARLINGTON
FOREST HILL
KENNEDALE
EDGECLIFF
EVERMAN
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VILLAGE
CROWLEY
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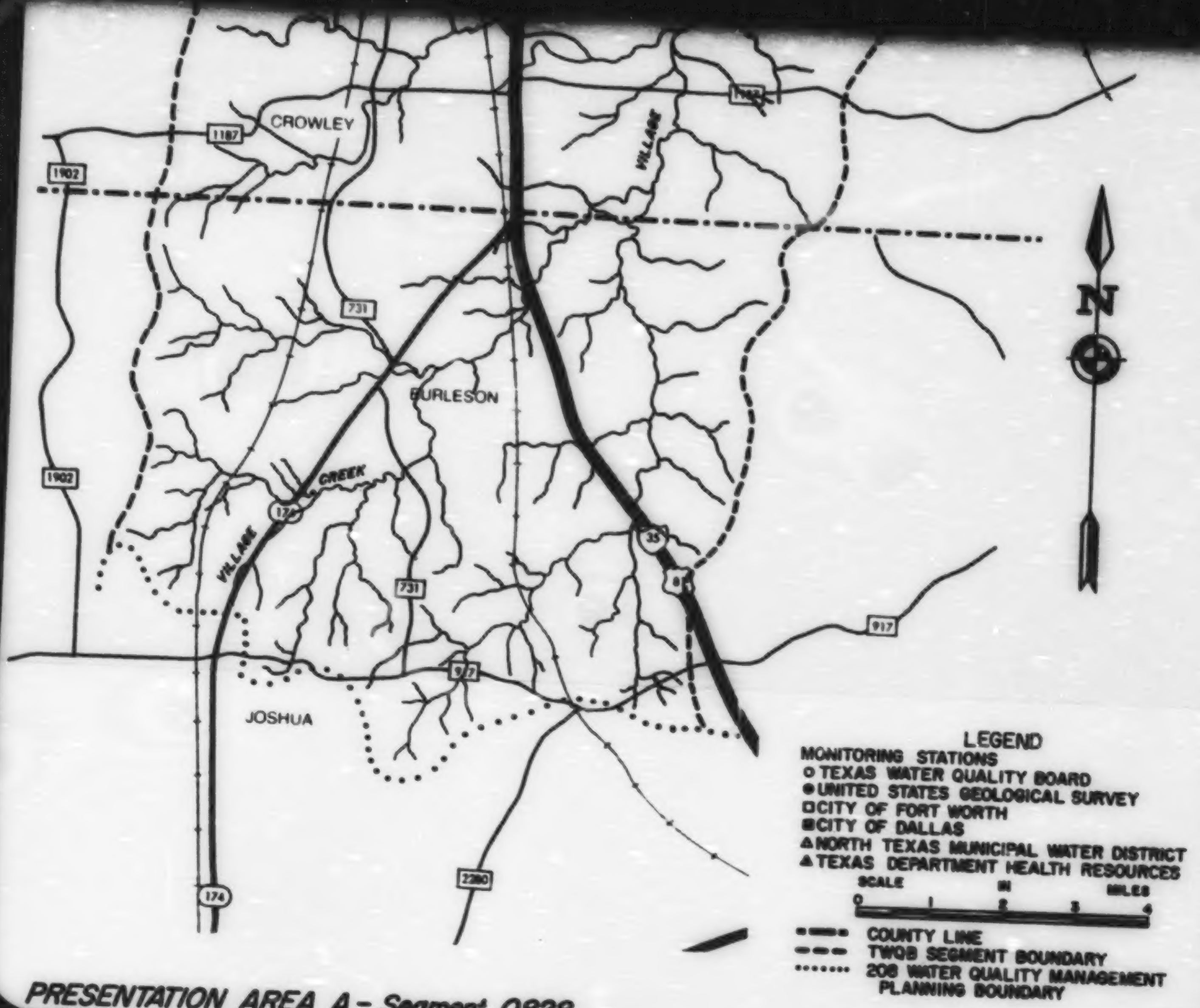
CROWLEY
1187
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731
BURLESON
CREEK
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VILLAGE
VILLAGE
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35
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917
JOSHUA
2280
174
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LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY

PRESENTATION AREA A - Segment 0828

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE A8

LAKE ARLINGTON - Segment 0828

Lake Arlington is located on Village Creek in Tarrant County. Impoundment of water began March 31, 1957, and first achievement of normal capacity was accomplished in April 1957. Lake Arlington has a drainage area of 370.4 square kilometers (143 square miles) and a capacity of 5.638×10^7 cubic meters (45,710 acre-feet) at an elevation of 167.6 meters (550.0 feet) above mean sea level.

A map of Lake Arlington is presented in Figure A8, showing existing monitoring stations.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Lake Arlington (Arl; TWQB 0828.01; USGS 08049200). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.8	38.5	7.5	9.0	60
Dissolved Oxygen	9.2	12.0	6.4	1.5	76
pH (pH units)	8.2	8.9	6.8	0.3	76
Conductivity (umhos/cm)	370	435	140	79	60
Total Suspended Solids	18	31	9	9	7
Volatile Suspended Solids	4	10	0	**	7
Total Dissolved Solids	208	244	164	22	25
Ammonia, as N	0.08	1.32	0.00	**	32
Nitrite, as N	0.01	0.06	< 0.01	**	20
Nitrate, as N	0.24	2.30	0.01	**	28
Nitrite + Nitrate, as N	0.06	0.20	0.00	**	25
Total Phosphate, as P	0.06	0.40	0.00	**	45
Orthophosphate, as P	0.02	0.10	< 0.01	**	28
Chloride, as Cl	30	103	18	7	202
Sulfate, as SO_4	39	58	21	6	190
Chlorophyll a (ug/l)	10	17	4	5	7
Secchi (cm)	89.1	204.2	40.0	**	48
Fecal Coliform (#/100 ml)	32*	760	1	**	7
Total Hardness, as $CaCO_3$	124	156	95	9	229
Noncarbonate Hardness, as $CaCO_3$	12	27	5	5	25
Bicarbonate Alkalinity	129	153	96	13	25
Calcium, as Ca	38	43	30	3.1	25
Fluoride, as F	0.3	0.3	0.2	0.0	25
Iron, as Fe	0.043	0.19	0.00	**	25
Magnesium, as Mg	5.9	7.2	4.1	0.7	25
Manganese, as Mn	0.007	0.03	0.00	**	25
Potassium, as K	4.8	5.7	4.1	0.4	25
Silica, as SiO_2	2.4	4.1	0.3	**	25
Sodium, as Na	28	34	20	4.5	25

continued. . .

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Lake Arlington were taken from TWQB (1976a).

Temperature - Not to exceed 35 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable range: 6.5 - 9.0. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 300 mg/l. Criterion met.
Chloride - Mean concentration not to exceed 100 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 100 mg/l. Criterion met.
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Recent Lake Arlington data reveal no problems in conjunction with TWQB (1976a) standards. Nutrient concentrations are high enough to sustain large phytoplankton populations, which are apparently present in Lake Arlington. The dissolved oxygen concentration was never reported to be less than 7.3 mg/l.

Figures A9 and A10 show, respectively, vertical profiles for summer and winter conditions in Lake Arlington. Parameters graphed against depth are temperature, dissolved oxygen, ammonia, and total phosphate.

Tributary Water Analyses - Tributaries entering Lake Arlington include Village Creek and Wildcat Branch. No data for either tributary were available.

Sediment Analyses - Recent Lake Arlington (TWQB 0828.01) sediment pollutant concentrations are presented below. All concentrations are in mg/kg (dry weight basis), unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Oil and Grease	351.8	388.5	315.0	-	2
Organic Nitrogen	826.75	839.00	814.50	-	2
Phosphorus in Particulates	184.0	350.0	18.0	-	2
Arsenic, as As	1.60	2.25	0.96	-	2
Barium, as Ba	244	461	27	-	2
Boron, as B	314	601.07	27	-	2
Cadmium, as Cd	0.64	0.69	0.59	-	2
Chromium (total), as Cr	17.2	18.1	16.4	-	2
Copper, as Cu	14.32	14.60	14.05	-	2
Lead, as Pb	20.7	20.9	20.5	-	2

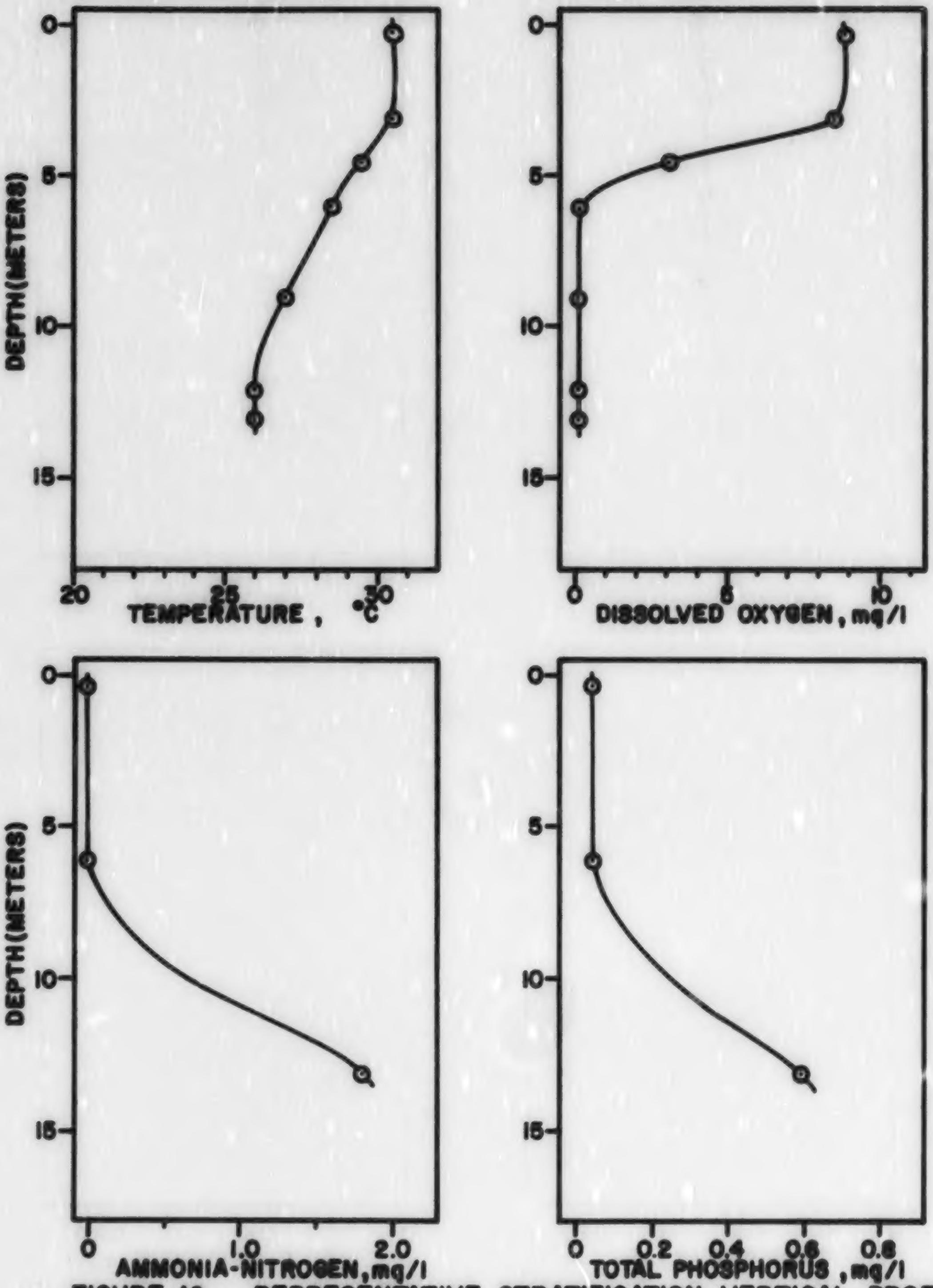


FIGURE A9. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN LAKE ARLINGTON (USGS STATION A_c) FOR TEMPERATURE, DISSOLVED OXYGEN, AMMONIA, AND TOTAL PHOSPHORUS ON SEPTEMBER 5, 1975 (TIME 0910).

(DATA FROM USGS 1971-1976b)

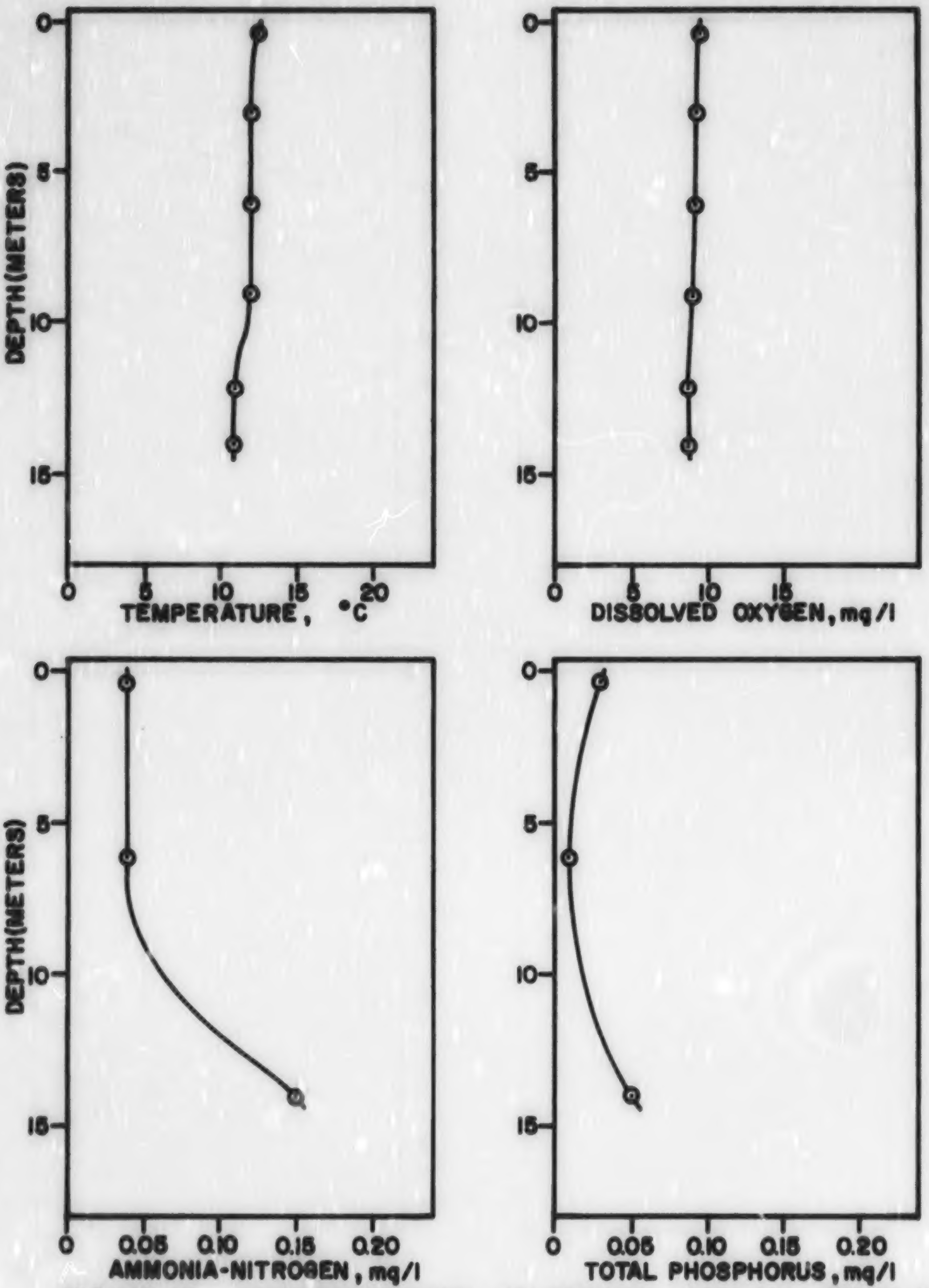


FIGURE A10. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN LAKE ARLINGTON (USGS STATION Ac) FOR TEMPERATURE, DISSOLVED OXYGEN, AMMONIA, AND TOTAL PHOSPHORUS ON JANUARY 29, 1975 (TIME 0915).
(DATA FROM USGS 1971-1976 b)

continued. . .

Parameter	Mean	Max	Min	S	N
Manganese, as Mn	276	287	265	-	2
Mercury, as Hg (wet weight)	66.5	133.0	0.0	-	2
Nickel, as Ni	10.0	13.6	6.4	-	2
Selenium, as Se	0.52	0.87	0.17	-	2
Silver, as Ag	1.02	1.53	0.50	-	2
Zinc, as Zn	53.0	67.8	38.3	-	2

-Standard deviation not computed when N is less than six.

In addition TWQB (1976b) states that sediment concentrations of copper and lead "indicate the possibility of unnatural sources" of these elements; however, reported levels are not considered a threat to water quality. Maxima reported for copper and lead in sediment were 62 mg/kg and 52 mg/kg respectively.

Biological
(10-1-74 through 6-30-76)

Bacteria - Recent bacteria data were summarized in the WATER ANALYSES section. The log. mean fecal coliform count of 32 organisms/100 ml was well within the limit of 200 organisms/100 ml. The high fecal coliform count reported was 760 organisms/100 ml. Data for total coliform and other bacteria were not encountered.

Plankton - During a given year, Lake Arlington experiences considerable problems with taste and odor resulting from excessive phytoplankton growth. The algal blooms generally contain large proportions of blue-green algae, particularly Anabaena sp.

Very little recent data were available. However, it appears that the trend from the last few years is continuing. Historical trends in the phytoplankton community are examined in the PLANKTON section under HISTORICAL WATER QUALITY AND TRENDS.

Aquatic Vegetation - No recent macrophyte surveys were encountered for Lake Arlington.

Macroinvertebrates - Aldridge (1975) conducted a detailed study of the Corbicula manilenais population in Lake Arlington. He found densities as high as 94.6 Corbicula per square meter in the lake.

Fishes - TPWD has conducted recent fish surveys on three lakes in the Dallas-Fort Worth 208 area. It has reported no recent fish surveys for Lake Arlington, however.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Water quality data were not abundant enough to examine them very effectively for trends. Data were available for water years 1973, 1974, and 1975 (TWQB 0828.01, USGS 08049200). The following table presents a summary of parameters that appeared to show some sort of trend.

Parameter	Water Year	Mean	Max	Min	S	N
Chloride, as Cl	1973	27	33	22	4	17
	1974	25	31	24	2	17
	1975*	30	103	18	24	202
Nitrate, as N	1973	0.01	0.30	0.00	0.10	12
	1974	0.04	0.07	0.03	-	3
	1975*	0.24	2.30	0.01	**	28
Total Phosphate, as P	1973	0.06	0.074	0.026	0.01	12
	1974	0.08	0.22	0.04	0.04	18
	1975*	0.06	0.40	0.00	**	45
Fecal Coliform (log. means)	1973		No Data Available			
	1974	6	16	1	-	3
	1975*	32	760	1	**	7

-Standard deviation not computed when N is less than six.
*WY 1975 plus data through 6-30-76.
**Data from a clearly non-normal distribution; no standard deviation computed.

The trend for chloride and phosphate appears to be one of relative consistency. Nitrate ion, on the other hand, appears to exhibit an increasing trend.

Tributary Water Analyses - No historical tributary data were encountered.

Sediment Analyses - No historical data for sediment pollutants were encountered for Lake Arlington.

Biological
(Prior to 10-1-74)

Bacteria - Very few historical bacteria data exist. Data appear to have remained within the TWQB standard, however. Available data for fecal coliform are presented in the above WATER ANALYSES table.

Plankton - Carr (1973) surveyed phytoplankton present in Lake Arlington. The results of this survey are presented in Table II, depicting the differences in composition between winter and summer

TABLE NO. II

PHYTOPLANKTON OF LAKE ARLINGTON
(TAKEN FROM CARR 1973)

Organism	ABUNDANCE January 15	 August 24
Green Algae		
Schroederia sp.	57	851
Ankistrodesmus sp.	57	511
Tetraedron trigonum		170
Scenedesmus quadricauda	57	170
Crucigenia tetrapedia		170
Tetrastrum sp.	114	170
Unidentified Chlorophytan	170	681
Unidentified Chlorophytan		170
Blue-Green Algae		
Chroococcus sp.		170
Merismopedia punctata		1,022
M. minima (?)		852
Oscillatoria sp.		60,286
Lyngbya sp.		1,192
Anabaena sp.		170
Diatoms		
Melosira sp.	6,074	
Synedra sp.	284	852
Flagellates		
Phacus sp.	57	
Trachelomonas volvocina	227	
Other unidentified flagellates		170
Miscellaneous	227	1,363
TOTALS	7,324	68,970

conditions. Data for Table II come from one representative station in Lake Arlington. It can be seen that the summer count is about nine times greater than the winter count. Also, blue-green algae, absent during the winter sampling, comprised 92% of the summer sample. Conversely, diatoms (particularly *Melosira* sp.) made up 86% of the winter sample, but only constituted about 1% of the summer sample.

Historical trends in phytoplankton concentrations for Lake Arlington are presented in Figures A11 and A12. In September, a total cell count of 90,000 cells/ml was reported (78% of the total were blue-green algae). Since that time, the maximum was 24,000 cells/ml. Each year follows basically the same pattern, with the greatest concentration occurring in September or October. This is more than likely a result of nutrient enrichment with the fall turnover.

It is also apparent that the greatest percentage composition comes from the blue-green algae, especially for the higher concentrations. The resultant taste and odor problems are substantial. Lake Arlington appears to support perhaps the highest concentrations of algae of any lake in the area, particularly blue-greens responsible for taste and odor (e.g., *Anabaena* sp.). During the summer of 1975, raw odor numbers ranged from 12 to 24. In late May 1970, an increase from 3 to 40 odor units occurred in just a few days.

Much has been done to attack the algae problem in Lake Arlington. Powdered carbon seems to have been the most effective treatment, although potassium permanganate, chlorine dioxide, and copper sulfate have been utilized. Discharges from numerous small STP's have been diverted around Lake Arlington. All of this seems to have resulted in a supression of algal proliferation in Lake Arlington.

Aquatic Vegetation - No historical surveys of aquatic vegetation in Lake Arlington were encountered. TPWD (1970), however, stated that aquatic vegetation posed no problem in Lake Arlington, and that only a few patches of pondweed and cattail existed.

Macroinvertebrates - Hall (1972) studied the density and diversity (Shannon-Wiener diversity index) of benthic organisms in Lake Arlington. Stations (9) ranged from near the dam (#1) along the west shore to the upper end of the lake (#9). Table III presents the sampling results. Hall (1972) found that the mean species diversity index ranged from 1.12 to 1.59 for the nine stations. The mean redundancy values ranged from 0.21 to 0.63. In general, the lower the species diversity index (and the higher the redundancy index), the greater the stress upon the biotic community. According to Wilhm and Dorris (1968), a Shannon-Wiener index of 0-1 indicates pollution and/or a high degree of stress, an index of 1-3 indicates moderate pollution and/or stress, and an index in excess of 3 indicates a high diversity and virtually no pollution or stress. Lowest diversity values came from the deep water station, the stations nearest the heated water outfall of the power plant, and the station where Village Creek enters the upper end of the lake. It should be pointed out that these stations would be expected to exhibit depressed diversity due to existing factors such as increased turbidity and increased temperature.

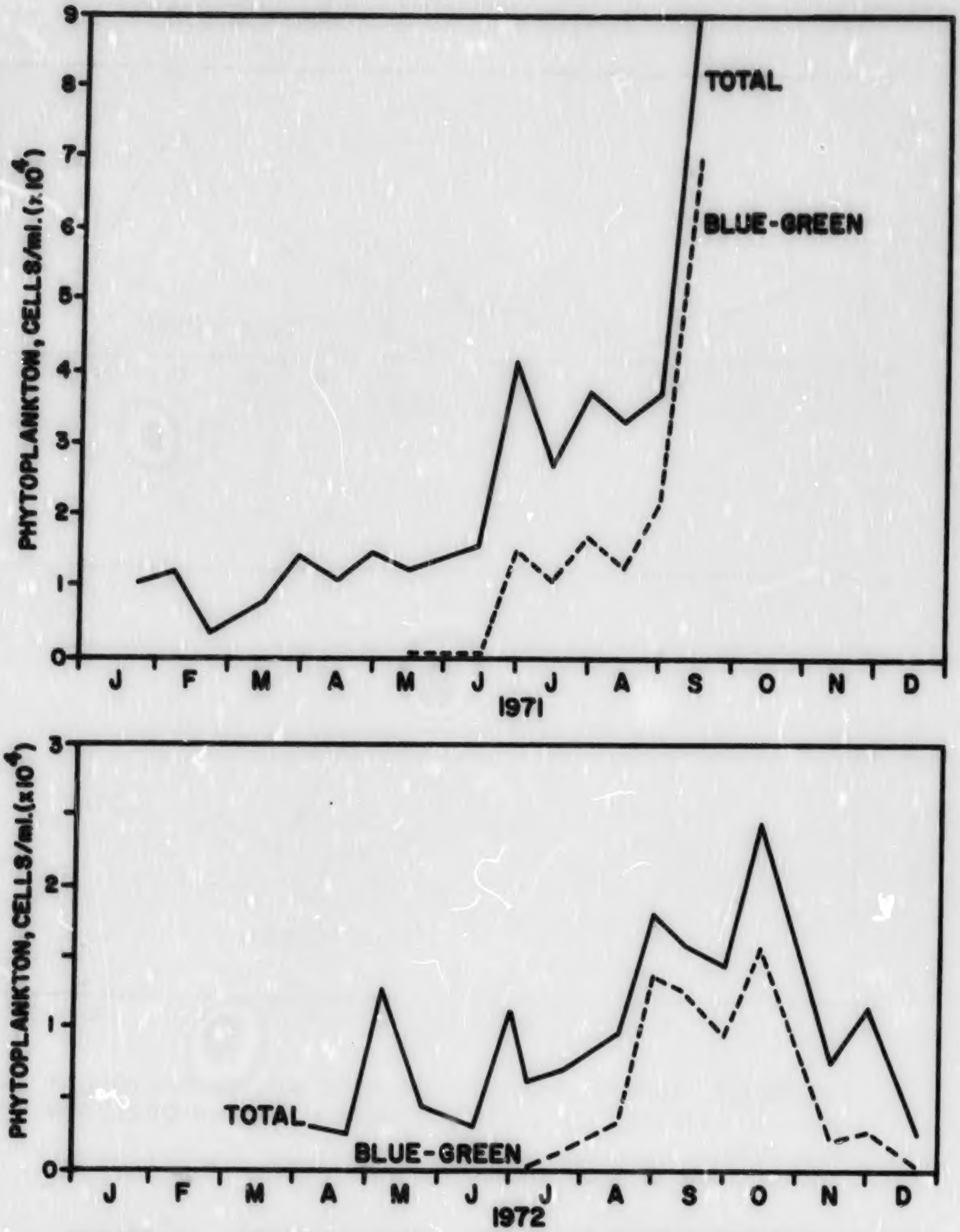


FIGURE A11. MONTHLY TOTAL AND BLUE-GREEN PHYTOPLANKTON CONCENTRATIONS FOR LAKE ARLINGTON (Segment 0828) FOR 1971 AND 1972.
(DATA FROM CITY OF ARLINGTON 1975)

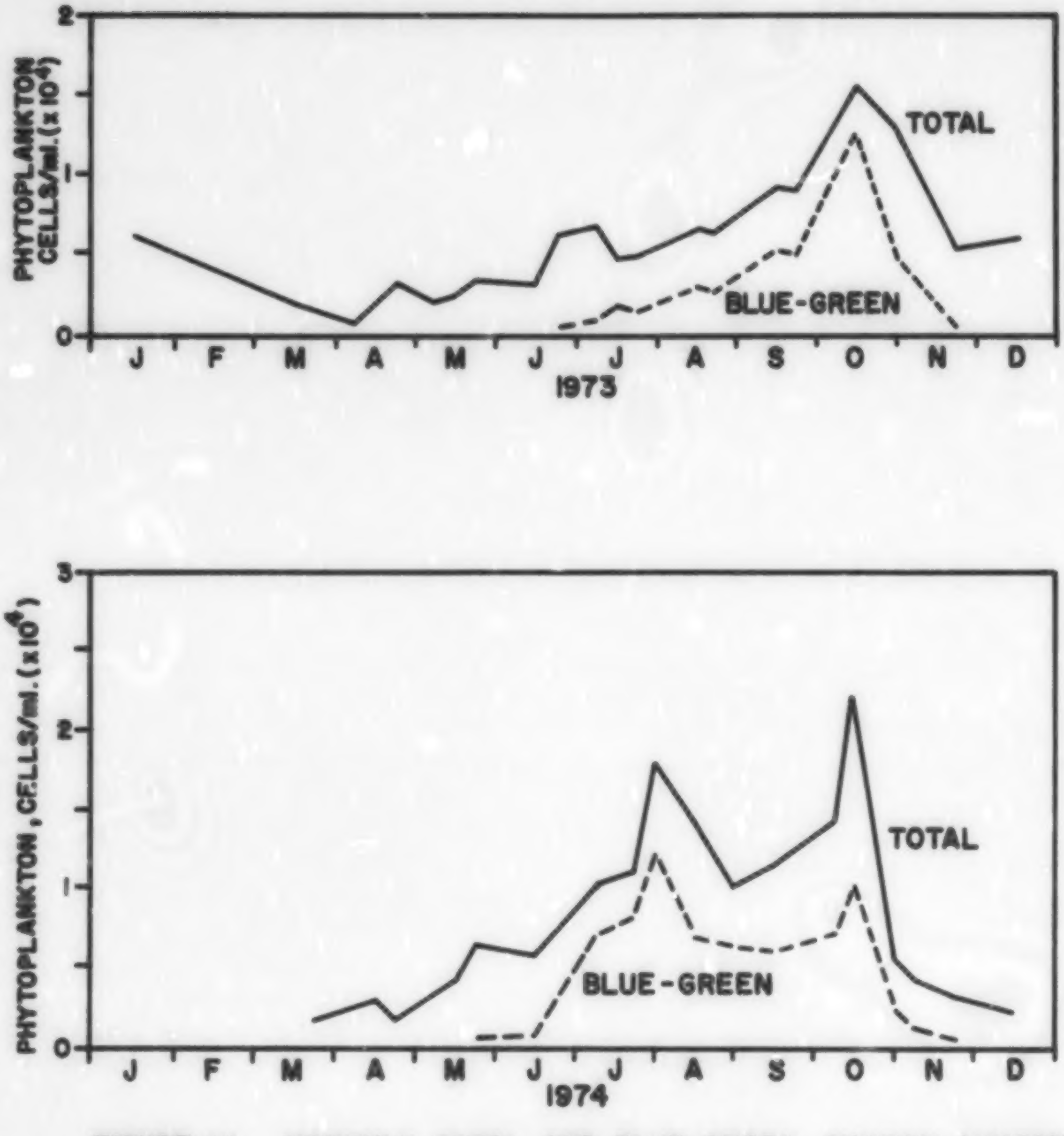


FIGURE A12. MONTHLY TOTAL AND BLUE-GREEN PHYTOPLANKTON CONCENTRATIONS FOR LAKE ARLINGTON (Segment 0828) FOR 1973 AND 1974.
(DATA FROM CITY OF ARLINGTON 1975)

TABLE NO. III

BENTHIC SPECIES DISTRIBUTION IN LAKE ARLINGTON (SEGMENT 0828)

(Taken from Hall 1972)

Organism	Number of Stations (Out of Nine Stations) Where Organism Was Encountered
DIPTERA	
Chaeoborus punctipennis	9
Tanypus stellatus	5
Tanypus sp. B	8
Procladius riparius	9
Coelotanypus concinnus	9
Pentaneura sp.	1
Pseudochironomus sp.	1
Chironomus (*Chironomus*) *tentans*	8
Chironomus (*Dicrotendipes*) sp.	1
Chironomus (*Cryptochironomus*) *fulvus*	9
Chironomus (*Cryptochironomus*) sp. (= *Harnischia*)	1
Glyptotendipes senilus ?	2
Polypedilum illinoense	7
EPHEMEROPTERA	
Hexagenia limbata	4
Caenis sp.	1
TRICHOPTERA	
Pycnopsyche sp.	1
MOLLUSCA	
Sphaerium transversum	1
ANNELIDA	
Tubifex sp.	9
Branchiura sowerbyi	8

Fishes - Several fish surveys have been conducted for Lake Arlington by the TPWD. After completion of the dam in 1957, Lake Arlington was stocked with largemouth bass, channel catfish, and sunfish. Table IV presents results of netting for 1955-1957, 1957-1958, and 1969. Between the first two periods, the percentages of rough and game fishes apparently changed very little. Between 1957-1958 and 1969, however, rough fish reportedly increased from 56.7% to 77% (by biomass) of the fish community. Rough fish numbers reportedly decreased from 50.8% to 42.3% during the same period. The river carpsucker accounted for the greatest increase in biomass of the rough fish.

Rutledge (1975) conducted a fish survey of the fish community in Lake Arlington. The results of this study are presented in Table V. According to Rutledge (1975), rough fish in Lake Arlington composed 54% (by number) and 77% (by biomass) of the fish community.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering Lake Arlington. However, Lake Arlington does have one industrial and two domestic point sources with flows in excess of 0.002 cubic meters per second, according to TWQB (1975-1976).

WATER USES

Domestic and Municipal

Lake Arlington is heavily used for domestic and municipal water supplies. The primary user is the City of Arlington. Water rights permits for domestic and municipal withdrawals from this segment total 1.11 x 10^7 cubic meters per year (9,000 acre-feet per year). The dependable yield from this lake, according to TWDB (1977), totaled 0.28 cubic meters per second (6.3 MGD).

Industrial

Lake Arlington is also moderately used as an industrial water supply. The sole industrial user is Texas Electric Service Company. Water rights permits for industrial withdrawals from this segment total 1.72 x 10^7 cubic meters per year (14,000 acre-feet per year), according to NCTCOG (1974). This water is utilized in cooling electrical generator steam condensing towers, and in doing so, a calculated average of 0.09 cubic meters per second (2.1 MGD) is consumed by evaporation. In addition, some of the water removed for domestic and municipal use may be consumed by local industry.

Agricultural

According to NCTCOG (1974), the waters of Lake Arlington are not used as an agricultural water supply.

TABLE NO. IV

FISHES COLLECTED IN LAKE ARLINGTON (SEGMENT 0828)
(TAKEN FROM TPWD 1957b, 1962, 1970)

	1955-1957*		1957-1958				1969			
Fish	Kg.	%	No.	%	Kg.	%	No.	%	Kg.	%
ROUGH FISH										
Gizzard shad	1.0	3.1	23	3.2	3.4	2.0	19	3.2	1.9	0.5
River carpsucker	1.5	4.3	200	27.6	51.8	31.2	175	29.0	234.6	60.7
Carp	4.6	13.3	36	5.0	11.2	6.8	31	5.1	59.6	15.4
Black bullhead	11.7	34.1	104	14.4	26.7	16.1				
Yellow bullhead	0.7	2.1	4	0.6	1.0	0.6	1	0.2	0.1	0.03
Threadfin shad							17	2.8	1.0	0.2
Golden shiner							12	2.0	0.8	0.2
ROUGH FISH TOTALS	19.5	56.9	367	50.8	94.1	56.7	255	42.3	298.0	77.0
GAME FISH										
Channel catfish	0.9	2.7	11	1.5	3.7	2.2	32	5.3	12.8	3.3
Largemouth bass	10.8	31.7	150	20.7	38.8	23.4	62	10.3	19.3	5.0
Green sunfish			1	0.1	0.1	0.1	4	0.7	0.4	0.1
Bluegill	2.8	8.0	52	7.2	4.3	2.6	119	19.7	6.9	1.8
White crappie	0.2	0.7	137	18.9	24.0	14.5	67	11.1	17.8	4.6
Black crappie			6	0.8	0.7	0.4				
Flathead catfish							4	0.7	9.6	2.5
White bass							50	8.3	20.7	5.4
Warmouth							4	0.7	0.5	0.1
Redear sunfish							7	1.2	0.6	0.2
GAME FISH TOTALS	14.7	43.1	357	49.2	71.6	43.2	349	58.0	88.6	23.0
TOTALS	34.2	100.0	724	100.0	165.7	99.9	604	100.3	386.6	100.0

TABLE NO. V

A COMPARISON BETWEEN GAME FISHES AND ROUGH FISHES IN LAKE ARLINGTON (SEGMENT 0828), 1973-74

(Taken from Rutledge 1975)

	Number	%	Biomass Kg	%
GAME FISHES				
Pylodictus olivaris	51	1.0	152.2	6.2
Ictalurus punctatus	370	7.0	86.7	3.6
Morone chrysops	422	7.9	132.1	5.4
Micropterus salmoides	106	2.0	43.4	1.8
Lepomis macrochirus	744	14.0	30.7	1.3
Pomoxis annularis	598	11.2	105.8	4.3
Miscellaneous sunfishes*	158	3.0	7.2	0.3
Game Fish Total	2449	46.1	558.1	22.9
ROUGH FISHES				
Dorosoma cepedianum	1327	24.9	102.7	4.2
Cyprinus carpio	795	14.9	1058.1	43.4
Notemigonus crysoleucas	65	1.2	5.5	0.2
Carpiodes carpio	683	12.8	712.4	29.2
Rough Fish Total	2870	53.8	1878.7	77.0
Grand Total	5319	99.9	2436.8	99.9

*Includes _Lepomis megalotis_, _L_. _microlophus_, _L_. _gulosis_, _L_. _cyanellus_, and _L_. _auritus_.

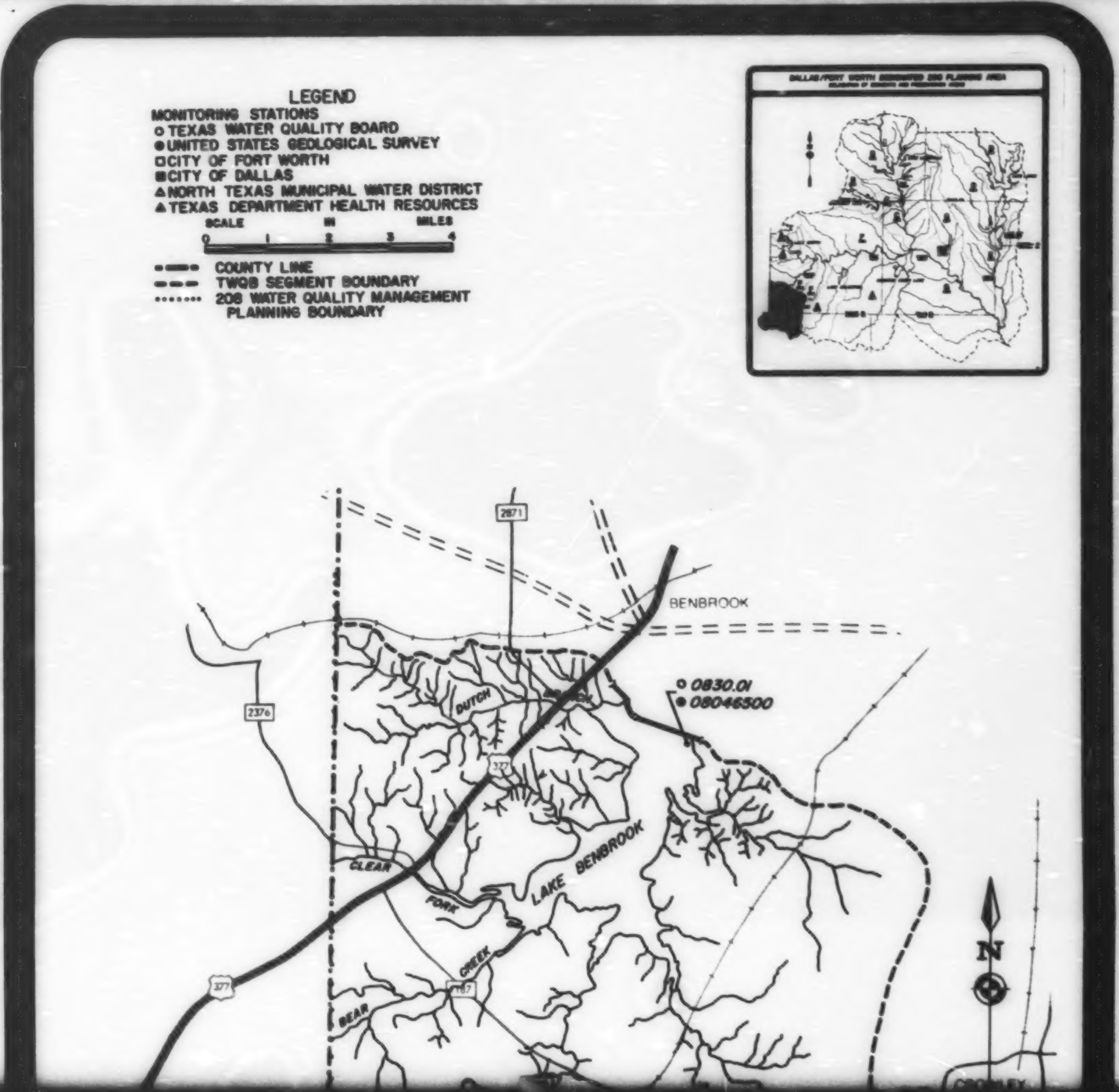
Recreational

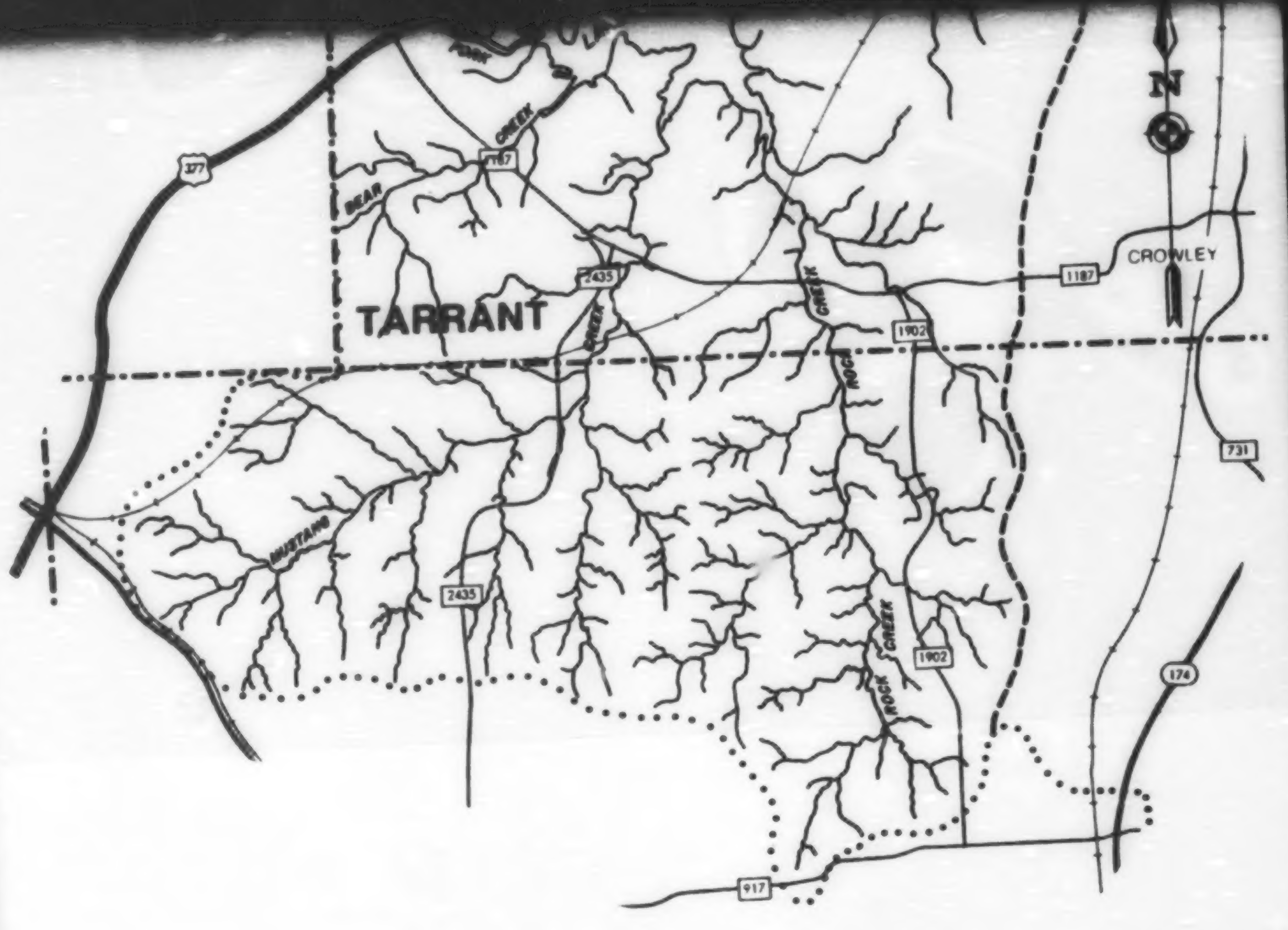
Lake Arlington is moderately used as a local source of recreation. Activities engaged in on the lake include boating, fishing, and water skiing. Other activities around the lake include hunting, camping, and hiking.

SUMMARY

Lake Arlington currently exhibits numerous eutrophic symptoms. Although all TWQB (1976a) criteria were met, nutrient levels were adequate to support substantial phytoplankton populations. Algae have posed water treatment problems for a number of years. In addition, both benthic macroinvertebrates (low diversity) and fishes (rough fishes) have problematic historical records. Few sediment data and no tributary data were encountered.

While Lake Arlington still receives some point source discharges, according to TWQB (1975-1976), much of the STP load has been diverted around the lake.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0
1
2
3
4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
2871
BENBROOK
○ 0830.01
● 08046500
2376
DUTCH
377
LAKE BENBROOK
CLEAR
FORK
CREEK
1187
BEAR
377
N


N
CROWLEY
1187
731
174
1902
ROCK
CREEK
917
2435
TARRANT
CREEK
BEAR
MUSTANG
PARK
377

PRESENTATION AREA A - Segment 0830

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE A13

BENBROOK LAKE - Segment 0830

Benbrook Lake was constructed during the period 1947-1950. It presently has a surface area of 15.3 square kilometers (3770 acres) and a volume of 1.09 x 10^8 cubic meters (88,250 acre-feet). The drainage area of Benbrook Lake is 1110 square kilometers (429 square miles). The mean depth of the lake is approximately 7.1 meters (23.4 feet).

A map of Benbrook Lake, showing existing monitoring stations, is presented in Figure A13.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Benbrook Lake (FW; TPWD; TWQB 0830.01; USGS 08046500). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	24.7	30.0	7.5	3.9	19
Dissolved Oxygen	7.9	11.2	5.3	1.5	18
pH (pH units)	8.0	8.4	7.5	0.2	13
Conductivity (umhos/cm)	335	375	240	24	16
Total Suspended Solids	13	28	9	**	6
Volatile Suspended Solids	7	16	4	**	6
Total Dissolved Solids	179	230	120	30	17
Total Solids	210	236	196	-	3
Ammonia, as N	0.33	1.5	0.0	-	5
Nitrate, as N	0.09	0.15	0.04	0.01	6
Orthophosphate, as P	0.018	0.049	0.00	**	7
Total Phosphate, as P	0.052	0.098	0.016	**	7
Chloride, as Cl	31	129	6.4	**	15
Sulfate, as SO_4	23	26	21	2	8
Total Alkalinity, as $CaCO_3$	158	360	100	74	14
Bicarbonate, as HCO_3	140	184	108	-	4
Carbonate, as CO_3	5	14	0	-	4
Total Hardness, as $CaCO_3$	132	159	120	-	4
Noncarbonate Hardness, as $CaCO_3$	8	8	8	-	1
Chlorophyll a (ug/l)	12	15	8	-	4
Secchi (cm)	83.2	122.8	49.4	27.8	11
Turbidity (JTU)	9	28	4	**	8
Biochemical Oxygen Demand$_5$	3	5	1	-	2
Total Organic Carbon	15	15	15	-	2
Sodium Absorption Ratio, SAR	0.6	0.6	0.6	-	1
Fecal Coliform (#/100 ml)	15*	31	5	-	4
Aluminum, as Al_2O_3	0.07	0.08	0.05	-	3
Calcium, as Ca	44	59	38	-	4
Fluoride, as F	0.20	0.23	0.18	-	4
Iron, as Fe	0.05	0.06	0.04	-	3

continued. . .

Parameter	Mean	Max	Min	S	N
Magnesium, as Mg	5	6.3	3	-	4
Potassium, as K	3.6	3.6	3.6	-	1
Silica, as SiO_2	6.8	7.7	5.6	-	4
Sodium, as Na	23	26	15	-	4

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Benbrook Lake (Segment 0830) were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable range: 7.0 - 9.0. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 300 mg/l. Criterion met.
Chloride - Mean concentration not to exceed 75 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 75 mg/l. Criterion met.
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Lake Benbrook water quality is good, with all reported dissolved oxygen values in excess of the 5.0 mg/l standard. The various nutrient concentrations are relatively low, and the chlorophyll a concentrations indicate little problem with eutrophic symptoms. The water in Benbrook Lake is moderately hard to hard, similar to other waters in the 208 area.

Figures A14 and A15 present vertical profiles in Benbrook Lake for the parameters temperature, dissolved oxygen, and pH. It may be noticed from Figure A15 that a high degree of stratification takes place with dissolved oxygen and pH, and that the thermocline (or metalimnion) occurs at an approximate depth of five to seven meters.

Tributary Water Analyses - Tributaries entering Benbrook Lake include Dutch Branch, Clear Fork Trinity River, Bear Creek, Mustang Creek, and Rock Creek. No recent data were encountered for any of these tributaries within the Dallas-Fort Worth 208 area.

Sediment Analyses - No recent analyses for sediment pollutants were encountered for Benbrook Lake.

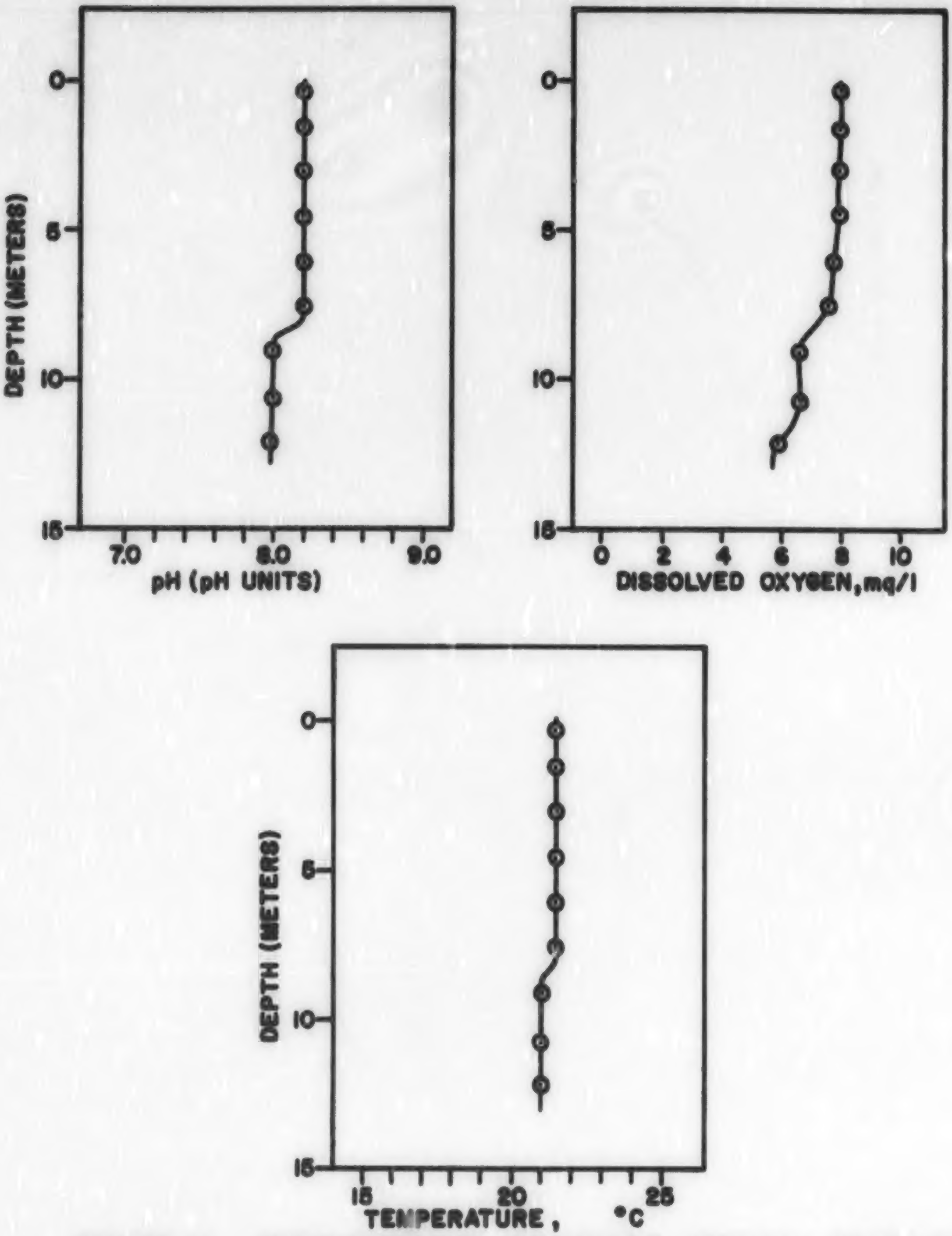


FIGURE A14. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN BENBROOK LAKE FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON OCTOBER 9, 1975 (TIME 1030).
(DATA FROM TWQB 0830.01)

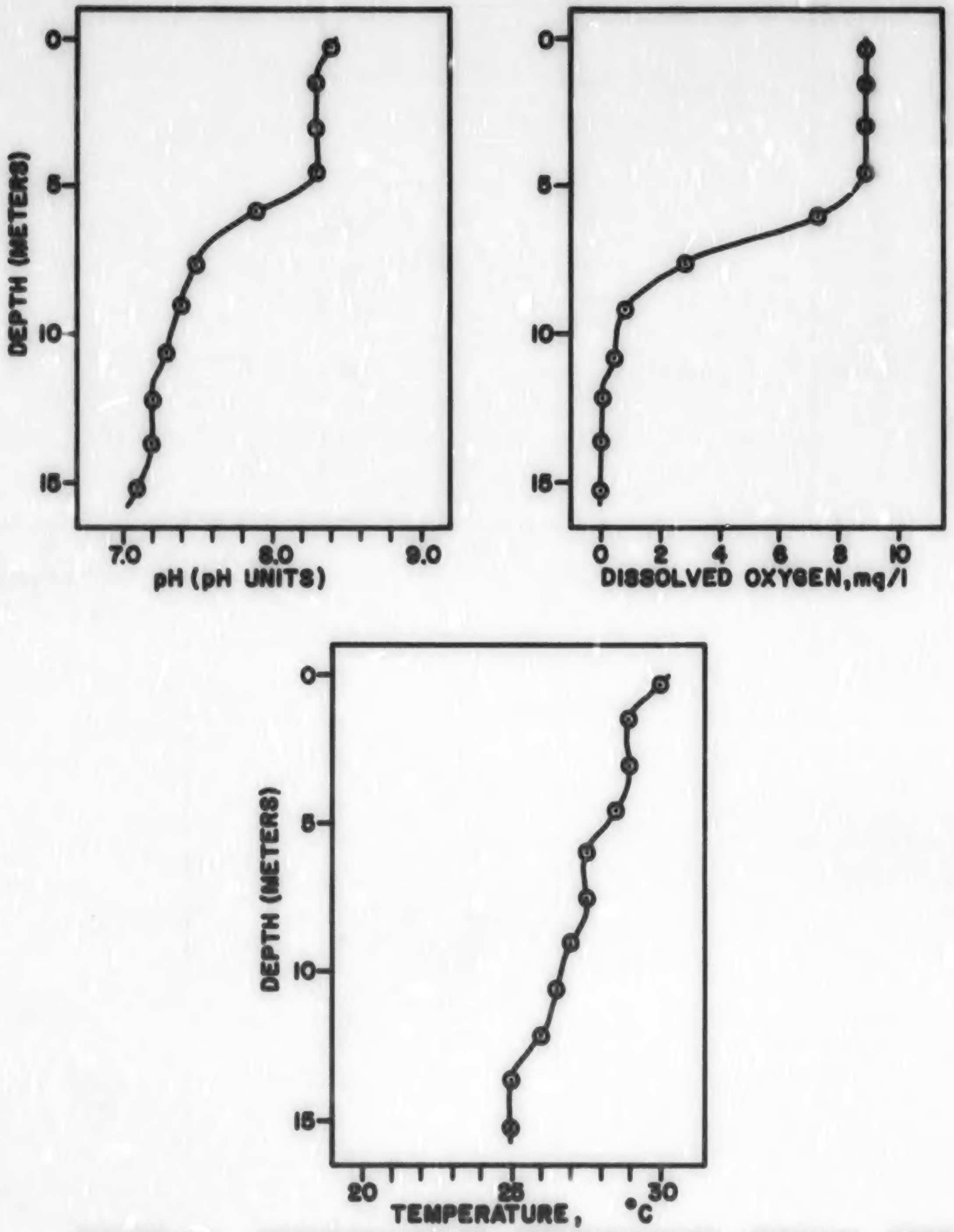


FIGURE A15. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN BENBROOK LAKE FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON JULY 28, 1975 (TIME 1030).
(DATA FROM TWQB 0830.01)

Biological
(10-1-74 through 6-30-76)

Bacteria - Recent bacteria data were summarized in the WATER ANALYSES table. The log. mean of the data was 15 organisms/100 ml, and the maximum value reported was 31 organisms/100 ml. No data were available on total coliform or other bacterial groups.

Plankton - No recent data on the phytoplankton or zooplankton communities in Benbrook Lake were available.

Aquatic Vegetation - TPWD (1976b) reports a complete vegetation survey for Benbrook Lake conducted during 1975. Macrophytes present, as well as approximate areal coverage of each, are presented in Table VI.

Macroinvertebrates - No recent data on macroinvertebrates in Benbrook Lake were encountered.

Fishes - TPWD (1976b) conducted a fish survey in Benbrook Lake. The results are presented as part of Table VII. Rough fish composed 56% (by number) and 86.8% (by biomass) of the total fish community sampled. The most abundant rough fish captured was the river carpsucker (Carpiodes carpio), which accounted for 16.6% (by number) of the fishes present. The most abundant game fish captured was the bluegill (Lepomis macrochirus), comprising 24.9% (by number) of the fishes netted.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Figure A16 presents historical trends for Benbrook Lake for the period 1961-1976. Parameters presented are pH, total dissolved solids, and chloride. All three parameters, while showing no clear increasing or decreasing trends, have remained within the TWQB (1976a) standards. Other parameters showed similar trends; no historical water quality problems were noticed.

Smith (1973) reported the waters of Benbrook Lake to be hard to very hard (bicarbonate type), to be low in nitrate and orthophosphate, and to stratify with regard to oxygen but not thermally.

Tributary Water Analyses - No historical data were encountered for tributaries entering Benbrook Lake.

Sediment Analyses - No historical data regarding the concentrations of contaminants in the sediment were encountered.

TABLE VI

BENBROOK LAKE VEGETATION SURVEY, 1975 SEGMENT 0830
(TAKEN FROM TPWD 1976b)

Common	Scientific	Degree of Infestation	% Lake Surface Covered
Black Willow	(*Salix nigra*)	Light	5.27
Buttonbush	(*Cephalanthus occidentalis*)	Light	2.82
Bushy Pondweed	(*Najas flexilis*)	Light	1.42
Broadleaf Pondweed	(*Potamogeton sp.*)	Light	0.70
Bulrush	(*Scirpus sp*)	Light	0.24
Muskgrass	(*Chara sp.*)	Light	0.14
Galingale	(*Cyperus sp.*)	Light	0.08
Cattail	(*Typha latifolia*)	Light	0.06
Spike Rush	(*Eleocharis obtusa*)	Light	0.05
Marshgrass	(*Panicum sp.*)	Light	0.05
Water Purslane	(*Didiplis diandra*)	Light	0.04
False Loosestrife	(*Ludwigia palustris*)	Light	0.005
Marsh Smartweed	(*Polygonum sp.*)	Light	0.004
Sago Pondweed	(*Potamogeton pectinatus*)	Light	0.002
Burhead	(*Echinodorus cordifolius*)	Light	0.002

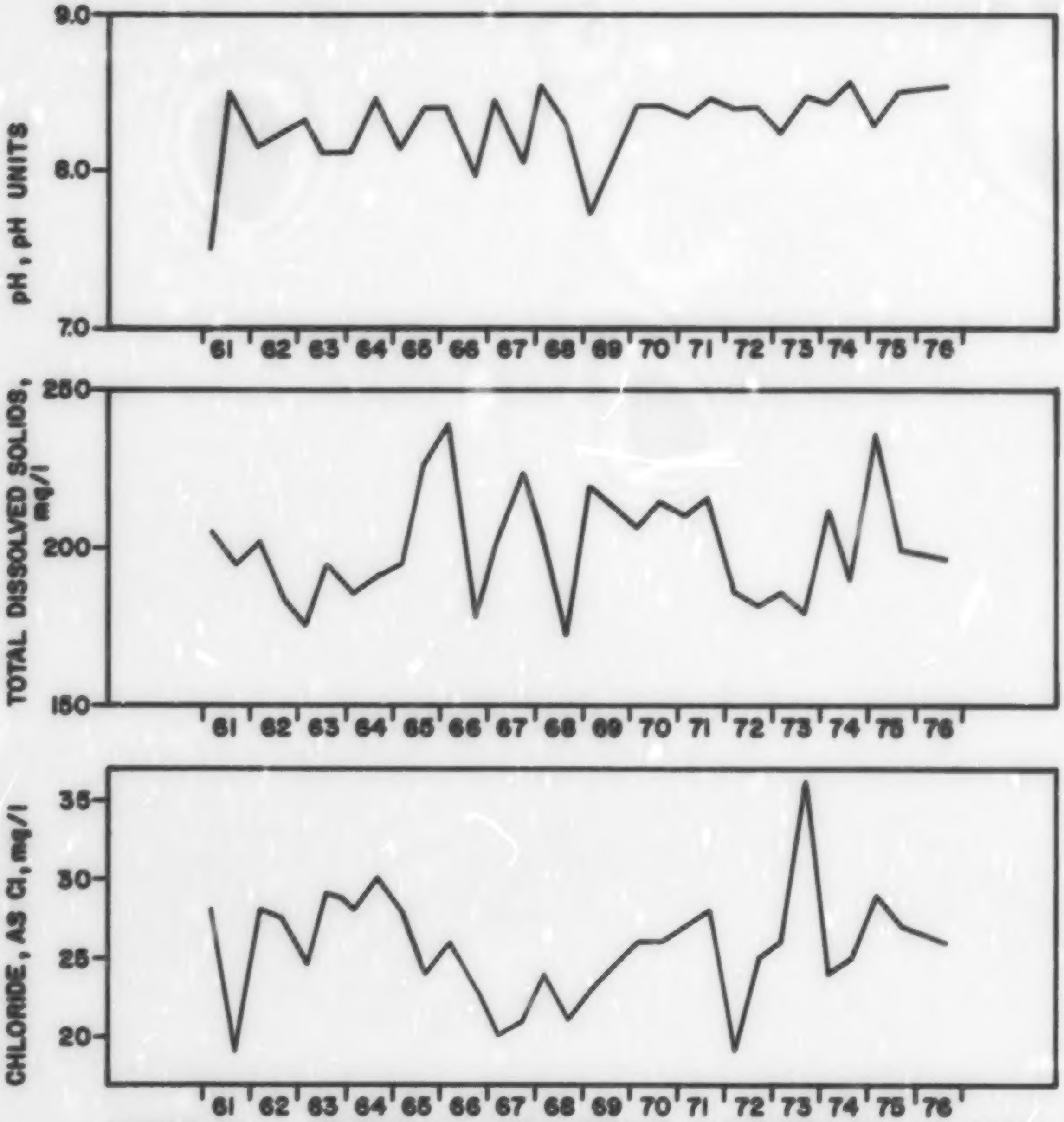


FIGURE A16. HISTORICAL DATA TRENDS EXHIBITED BY pH, TOTAL DISSOLVED SOLIDS, AND CHLORIDE FOR BENBROOK LAKE (Segment 0830).

(DATA FROM CITY OF FORT WORTH 1961-1976)

Biological

(Prior to 10-1-74)

Bacteria - Very little historical bacteria data were encountered. TWQB (1972-1976) conducted several fecal coliform analyses during WY 1974. The mean fecal coliform concentration was only 3 organisms/100 ml. No other bacteria data were encountered for Benbrook Lake.

Plankton - Cappel (1970) conducted a quantitative and qualitative study of the phytoplankton and zooplankton communities in Benbrook Lake and tributaries entering Benbrook. Tributaries sampled were Mustang Creek, Bear Creek, Rocky Creek, Dutch Branch, and the West Fork Trinity River. Plankton genera found exclusively within the lake were *Alona*, *Aphanocapsa*, *Dispora*, *Mallomonas*, *Trochosphaeria* (sic), and *Vampyrella*. Plankton genera discovered only in tributaries samples were *Actinastrum*, *Carchesium*, *Diaphanosoma*, *Diatoma*, *Euastrum*, *Franceia*, *Netrium*, *Platydorina*, *Pleodorina*, *Richteriella*, *Surirella*, and *Tokophyra*.

Aquatic Vegetation - No past vegetation surveys for Benbrook Lake were encountered.

Macroinvertebrates - Other than the parasitic Copepoda presented in Table IX, no historical macroinvertebrate data were encountered for Benbrook Lake.

Fishes - Numerous fish surveys have been conducted on Benbrook Lake (TPWD 1954, 1955, 1956, 1976). The results of these surveys are summarized and compared in Table VII and Figure A17. The high percentages of largemouth bass reported during 1953-1954 were in all probability due largely to stocking efforts undertaken during 1953. Table VIII summarizes stocking for Benbrook Lake for 1953.

Of the eight fish species stocked in 1953, two (the warmouth and black crappie) were not encountered during the 1975 netting survey. The overall trend appears to be one of decreasing numbers and increasing pounds of rough fish. Conversely, the trend in game fish appears to be one of increasing numbers and decreasing pounds.

Twenty years ago, TPWD (1956) stated that "the population of fish has changed from predominantly game fish to predominantly rough fish during the past three and one-third years of study." Evidently, the largemouth bass suffered from a number of factors, including overcrowding and parasitism.

Greene (1968), studying the feeding habits of the white crappie (*Pomoxis annularis*), found that the threadfin shad (*Dorosoma petenense*) constitued 96.2 percent of the crappie's diet. Similarly, Kerby (1965) studies the ecology and feeding habits of the largemouth bass, *Micropterus salmoides*.

TABLE NO. VII

TRENDS IN THE FISH COMMUNITY FOR BENBROOK LAKE (SEGMENT 0830)
(DATA FROM TPWD 1954, 1957, 1976)

FISH	1953-1954				1955-1956				1975			
	NO.	(%)	Kg	(%)	NO.	(%)	Kg	(%)	NO.	(%)	Kg	(%)
Rough Fish												
Gizzard shad	61	(2.8)	19.5	(2.6)	153	(11.8)	12.6	(3.4)	27	(9.3)	4.0	(1.9)
Carpsucker	7	(0.3)	5.9	(0.8)	3	(0.2)	4.0	(1.1)	48	(16.6)	97.6	(46.5)
Spotted sucker	23	(1.1)	12.3	(1.6)	609	(51.5)	252.2	(67.3)	28	(9.7)	15.2	(7.2)
Carp	7	(0.3)	4.2	(0.6)	15	(1.3)	3.4	(0.9)	32	(11.1)	62.5	(29.7)
Black bullhead	67	(3.1)	24.4	(3.3)	59	(5.0)	7.8	(2.1)	1	(0.3)	0.1	(0.1)
Yellow bullhead	73	(3.3)	20.7	(2.7)	9	(0.8)	1.7	(0.5)				
Grey redhorse	1	(0.05)	0.4	(0.05)								
Golden shiner									19	(6.6)	2.0	(0.9)
Freshwater drum									7	(2.4)	1.0	(0.5)
Rough Fish Total	239	(11.0)	87.4	(11.6)	848	(70.6)	281.7	(75.3)	162	(56.0)	182.4	(86.8)
Game Fish												
Channel catfish	32	(1.5)	16.8	(5.3)	29	(2.4)	12.4	(3.3)	11	(3.8)	10.4	(5.0)
Largemouth bass	1,854	(84.8)	614.1	(81.9)	45	(3.8)	33.7	(9.0)	6	(2.1)	2.0	(1.0)
Bluegill sunfish	33	(1.5)	3.8	(0.5)	22	(1.9)	1.6	(0.4)	72	(24.9)	4.7	(2.2)
White crappie	6	(0.3)	1.5	(0.2)	253	(21.4)	45.3	(12.1)	7	(2.4)	2.6	(1.3)
Kentucky spotted bass	1	(0.05)	0.4	(0.04)								
Warmouth	2	(0.1)	0.2	(0.02)								
Green sunfish	6	(0.3)	1.0	(0.1)					2	(0.7)	0.2	(0.1)
White bass									15	(5.2)	6.7	(3.2)
Yellowbelly sunfish	13	(0.6)	1.2	(0.2)								
Rockbass	1	(0.05)	0.2	(0.04)								
Redbreast sunfish									4	(1.4)	0.2	(0.1)
Longear sunfish									6	(2.1)	0.4	(0.2)
Redear sunfish									4	(1.4)	0.5	(0.2)
Game Fish Totals	1,948	(89.2)	639.2	(88.3)	349	(29.5)	93.0	(24.8)	127	(44.0)	27.7	(13.3)
TOTALS	2,187	(100.2)	726.6	(99.9)	1,197	(100.1)	374.7	(100.1)	289	(100.0)	210.1	(100.1)

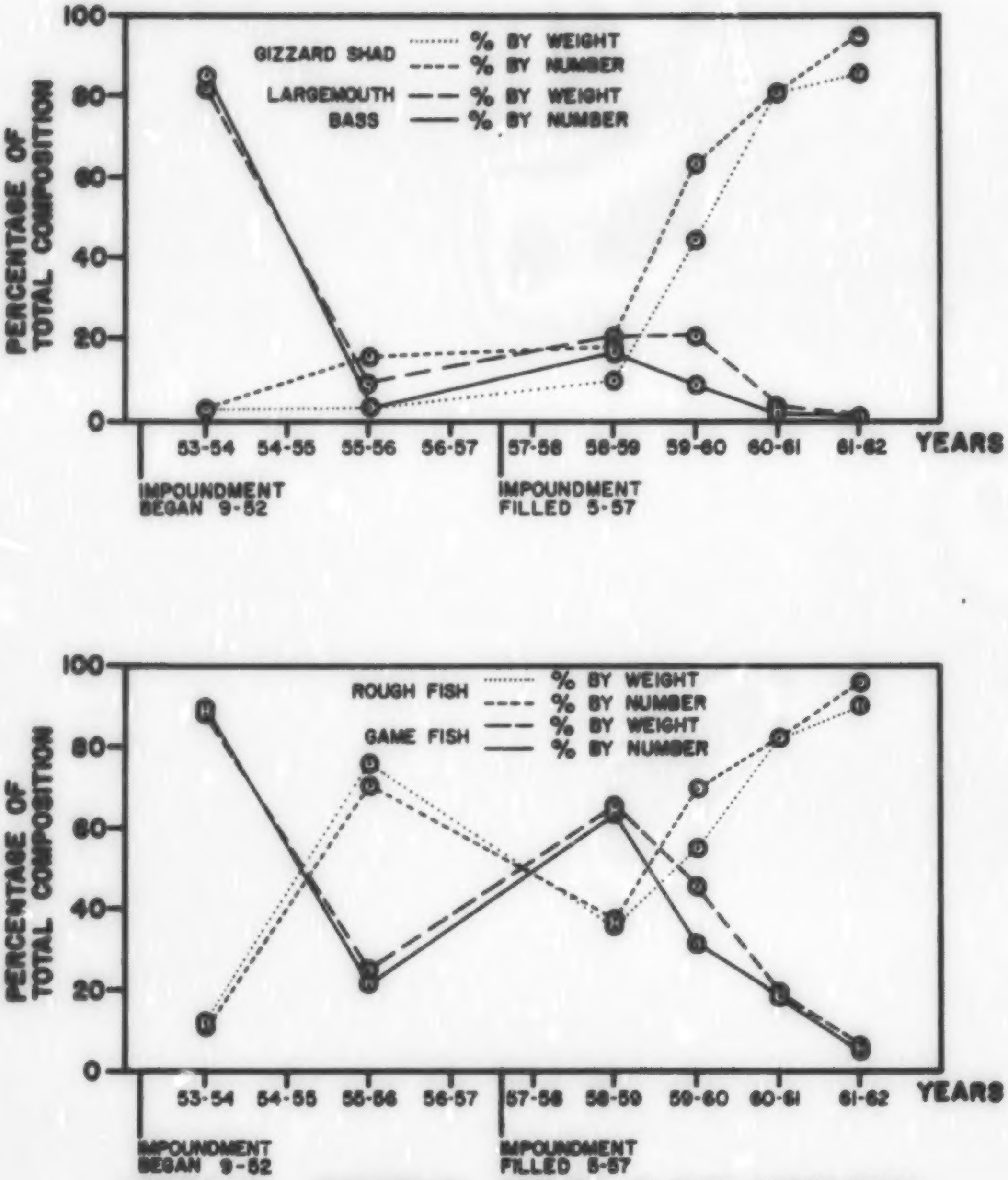


FIGURE A17. HISTORICAL TRENDS IN FISH COMMUNITY STRUCTURE FOR BENBROOK LAKE (Segment 0830).
(DATA FROM TPWD 1954-1963)
SAMPLING DONE BY GILL NET

TABLE NO. VIII

STOCKING OF FISH IN BENBROOK LAKE, TARRANT COUNTY, TEXAS, BY STATE AND FEDERAL FISH HATCHERIES IN 1953. (TAKEN FROM TPWD 1954)

Species	State Hatchery	Federal Hatchery	Total Stocked
Channel catfish (*Ictalurus punctatus*)	25,875		25,875
Largemouth Bass (*Micropterus salmoides*)	270,325	100,000	370,325
Warmouth Bass (*Chaenobryttus coronarius*)	40,075		40,075
Redear Sunfish (*Lepomis microlophus*)	50,525		50,525
Bluegill Sunfish (*Lepomis macrochirus*)	22,325		22,325
Longear Sunfish (*Lepomis megalotis*)	4,500		4,500
White Crappie (*Pomoxis annularis*)	11,300		11,300
Black Crappie (*Pomoxis nigro-maculatus*)	23,650		23,650
Total	448,575	100,000	548,575

Lawrence (1963) studied parasites of five fishes in Benbrook Lake. Table IX summarizes his results. Table IX reveals a high degree of parasitism afflicting many of the fish species present in Benbrook Lake. Approximately 89% of both the bluegill (*Lepomis macrochirus*) and the white crappie (*Pomoxis annularis*) captured were parasitized.

Table X lists fishes collected in three tributaries entering Benbrook Lake. TPWD (1957b) surveyed fishes within Bear Creek, Mustang Creek, and Rocky Creek. Relatively large numbers of Gizzard Shad and Green Sunfish were encountered in Mustang Creek.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering Benbrook Lake. However, there are no industrial point sources and one domestic point source in the Benbrook Lake watershed, according to TWQB (1975-1976).

WATER USES

Domestic and Municipal

Benbrook Lake is moderately used for domestic and municipal water supplies. The primary users are the City of Benbrook and the City of Fort Worth. Both of these cities have obtained water rights permits which entitle them to ten percent of the storage of the reservoir or 8.9×10^5 cubic meters per year (725 acre-feet per year) each. The total estimated dependable yield of the reservoir, according to TWDB (1977), is 0.40 cubic meters per second (9.2 MGD).

Industrial

There are no official permits issued authorizing the removal of water from Benbrook Lake for industrial purposes, according to NCTCOG (1974). However, some of the water removed for domestic and municipal purposes is utilized in private industries in both the City of Benbrook and the City of Fort Worth.

Agricultural

According to NCTCOG (1974), there is no official authorization to use the water of Benbrook Lake as an agricultural water supply.

Recreational

Benbrook Lake is heavily used as a local source of recreation. Activities engaged in on the lake include boating, water skiing, swimming, and fishing.

TABLE NO. IX

MORE FREQUENTLY FOUND PARASITES, THEIR HOSTS, AND PERCENTAGE OF HOST INFECTION FOR BENBROOK LAKE (SEGMENT 0830)

(TAKEN FROM LAWRENCE 1963)

HOST	PARASITE	NO. FISH POSTED	NO. FISH INFECTED	%
Ictalurus punctatus	Corallobothrium fimbriatum and/or C. giganteum	21	11	52.4
Chaenobryttus gulosus	Ergasilus sp.	5	3	60.0
	Posthodiplostomum minimum	5	3	60.0
Lepomis macrochirus	P. minimum	66	59	89.4
Micropterus salmoides	Ergasilus sp.	17	13	76.5
	Neoechinorhynchus cylindratus		12	70.6
Pomoxis annularis	Ergasilus sp.	191	169	88.5

TABLE NO. X

FISHES COLLECTED IN BEAR CREEK, MUSTANG CREEK, AND ROCKY CREEK (TAKEN FROM TPWD 1957b)

Fish	No.	%
BEAR CREEK		
Gizzard shad	2	3.7
Red shiner	3	5.6
Parrot minnow	20	37.0
Black Bullhead	10	18.5
Mosquitofish	4	7.4
Largemouth bass	2	3.7
Green sunfish	12	22.2
Bluegill	1	1.9
BEAR CREEK TOTALS	54	100.0
MUSTANG CREEK		
Gizzard shad	104	38.0
Banded tetra	1	0.4
Spotted sucker	3	1.1
Blacktail shiner	6	2.2
Red shiner	33	12.0
Parrot minnow	6	2.2
Mosquitofish	1	0.4
Largemouth bass	3	1.1
Green sunfish	110	40.1
Bluegill	7	2.6
MUSTANG CREEK TOTALS	274	100.1
ROCKY CREEK		
Gizzard shad	2	5.9
Blacktail shiner	13	38.2
Red shiner	6	17.6
Parrot minnow	7	20.6
Largemouth bass	1	2.9
Green sunfish	4	11.8
Bluegill	1	2.9
ROCKY CREEK TOTALS	34	99.9

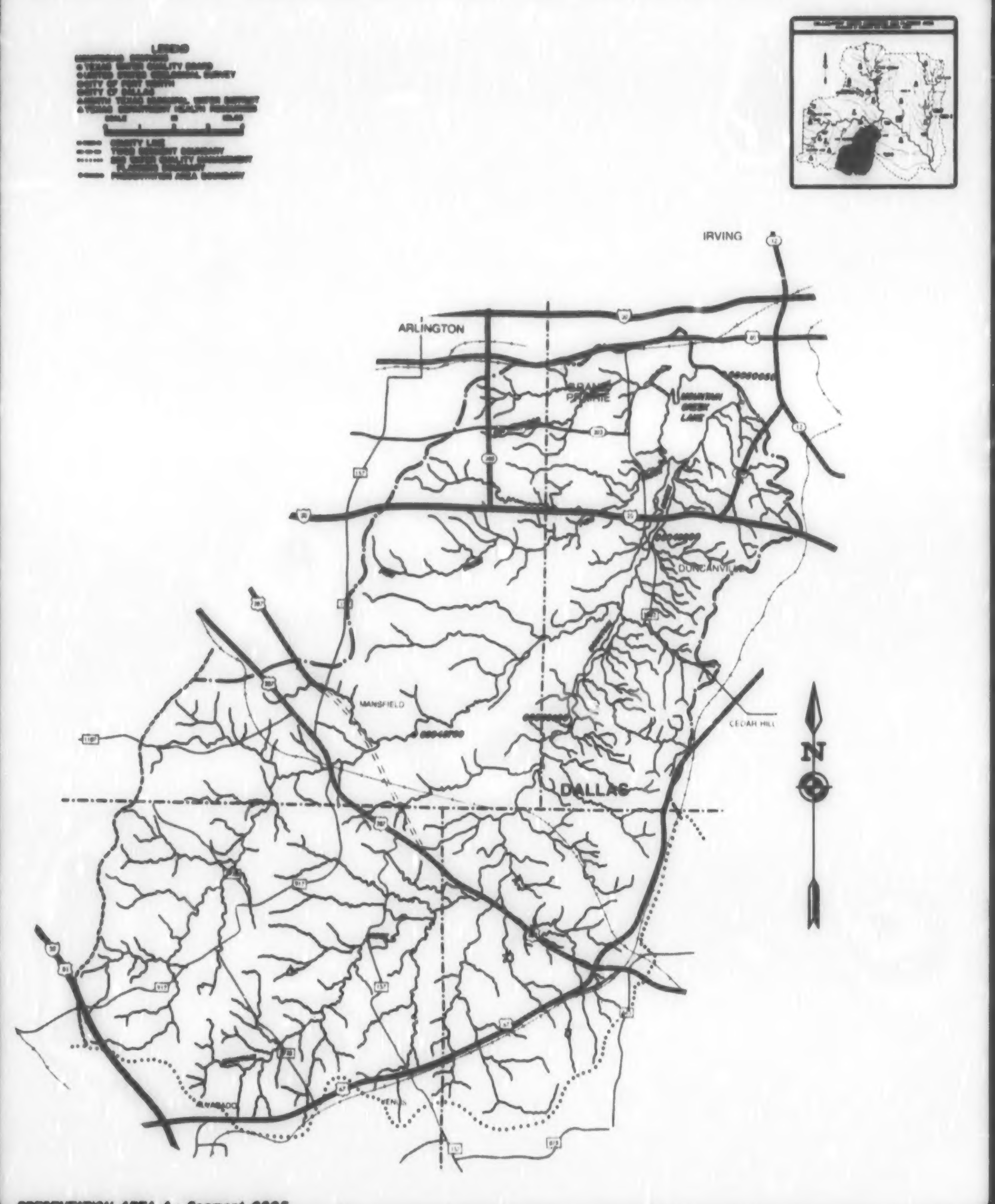
Navigational

Benbrook Lake is a Corps of Engineers project in which the water supply capability was allocated to navigational uses, in case a federal navigation project should be implemented on the Trinity River and in case supplemental flow should be required downstream. Such a project has been authorized by Congress but not implemented to date, and no water has yet been used for that purpose. The navigation project is now being restudied by the Corps of Engineers, and in the interim, as described above, some of the water supply is being used for domestic and municipal water uses.

SUMMARY

Water quality within Benbrook Lake appears to be quite good. All TWQB (1976a) criteria were met. While water quality data were not overly abundant, little problem seemed to be indicated with regard to major parameters. Water quality data were insufficient for trend analyses. Benbrook Lake exhibits a considerable degree of summer stratification.

Tributary and sediment data for Benbrook Lake were lacking. Available biological data indicated a predominance of rough fish species in the lake, both historically and recently. Little else was indicated by the remainder of the biological data.


LEGEND
TEXAS WATER QUALITY BOARD
UNITED STATES GEOLOGICAL SURVEY
CITY OF FORT WORTH
CITY OF DALLAS
COUNTY LINE
PRESENTATION AREA BOUNDARY
IRVING
ARLINGTON
GRAND PRAIRIE
MOUNTAIN CREEK LAKE
DUNCANVILLE
MANSFIELD
CEDAR HILL
DALLAS
ALVARADO
VENUS
N

PRESENTATION AREA A - Segment 0805

TRINITY RIVER AUTHORITY OF TEXAS
Planning and Environmental Management Division

December 1976
FIGURE A18

MOUNTAIN CREEK LAKE

Impoundment of water in Mountain Creek Lake began in March 1937. Mountain Creek Lake has a surface area of 10.97 square kilometers (2710 acres) and a volume of 2.82 x 10^7 cubic meters (22,840 acre-feet). It has a drainage area of 764 square kilometers (295 square miles). The mean depth of Mountain Creek Lake is 2.6 meters (8.4 feet).

A map of Mountain Creek Lake and its watershed, showing existing monitoring stations, is presented in Figure A18. Mountain Creek Lake and its upstream watershed are not a specifically designated TWQB segment and fall into the category: Segment 0800 - Other Waters.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Mountain Creek Lake (USGS 08050050). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	14.5	14.5	14.5	-	1
pH (pH units)	7.7	7.7	7.7	-	1
Conductivity (umhos/cm)	448	448	448	-	1
Total Dissolved Solids	265	265	265	-	1
Chloride, as Cl	17	17	17	-	1
Sulfate, as SO_4	90	90	90	-	1
Bicarbonate, as HCO_3	120	120	120	-	1
Carbonate, as CO_3	0	0	0	-	1
Total Hardness, as $CaCO_3$	150	150	150	-	1
Noncarbonate Hardness, as $CaCO_3$	48	48	48	-	1
Fluoride, as F	0.4	0.4	0.4	-	1
Calcium, as Ca	51	51	51	-	1
Magnesium, as Mg	4.7	4.7	4.7	-	1
Silica, as SiO_2	9.0	9.0	9.0	-	1
Sodium, as Na	26	26	26	-	1
Potassium, as K	7.4	7.4	7.4	-	1
Sodium Absorption Ratio, SAR	0.9	0.9	0.9	-	1

-No standard deviation computed when sample size is less than six.

Water Quality Standards - Mountain Creek Lake and the corresponding watershed have not been designated a water quality segment by the TWQB. Therefore, no water quality standards exist for this watershed in TWQB (1976a).

Tributary Water Analyses - Two monitoring stations exist on Mountain Creek upstream from Mountain Creek Lake. They are Mountain Creek near Cedar Hill (USGS 08049600) and Mountain Creek near Duncanville (USGS 08049900). The following table summarizes recent available data for these two stations. All concentrations are in mg/l, unless otherwise specified.

Mountain Creek (USGS 08049600, 08049900)
(10-1-74 through 6-30-76)

Parameters	Mean	Max	Min	S	N
Temperature (C)	17.8	28.0	5.0	6.1	35
Dissolved Oxygen	7.5	14.2	3.5	2.3	35
pH (pH units)	7.5	8.4	6.9	0.3	35
Conductivity (umhos/cm)	1027	1820	448	354	35
Turbidity (JTU)	53	200	1	**	35
Total Suspended Solids	119	928	6	**	35
Volatile Suspended Solids	31	296	0	**	35
Total Dissolved Solids	665	1260	265	249	35
Ammonia, as N	0.09	1.0	0.01	**	35
Nitrite, as N	0.01	0.07	0.00	**	35
Nitrate, as N	0.29	1.0	0.00	**	35
Organic Nitrogen, as N	0.76	1.4	0.20	0.26	35
Total Kjeldahl Nitrogen, as N	0.85	2.3	0.21	0.36	35
Total Phosphate, as P	0.20	2.0	0.03	**	35
Chloride, as Cl	50	110	14	**	35
Sulfate, as SO_4	274	570	80	122	35
Bicarbonate, as HCO_3	215	400	106	81	35
Carbonate, as CO_3	1	10	0	**	35
Total Hardness, as $CaCO_3$	333	540	150	122	35
Noncarbonate Hardness, as $CaCO_3$	157	320	0	**	35
Color (Pt-Co units)	11	40	0	**	35
Biochemical Oxygen $Demand_5$	2.4	6.1	.7	**	35
Total Organic Carbon	8.4	17	4.1	3.1	35
Silica, as SiO_2	8.3	25	1.8	**	35
Calcium, as Ca	115	190	53	41	35
Magnesium, as Mg	10.6	21	3.5	**	35
Sodium, as Na	88	200	27	44	35
Potassium, as K	10	25	4.7	5.0	35
Sodium Absorption Ratio, SAR	2.1	4.4	0.9	0.9	35
Phenols (ug/l)	3	15	0	**	32
Methylene-Blue-Active Sub.	0.04	0.2	0.0	**	34
Fluoride, as F	0.7	2.6	0.5	**	30
Aluminum, as Al (ug/l)	18	60	0	**	13
Arsenic, as As (ug/l)	4	17	0	**	13
Boron, as B (ug/l)	230	420	80	98	12
Cadmium, as Cd (ug/l)	0	0	0	0	13
Chromium, as Cr (ug/l)	1	10	0	**	13
Cobalt, as Co (ug/l)	0.3	2	0	**	13
Copper, as Cu (ug/l)	6	50	0	**	13
Iron, as Fe (ug/l)	20	80	0	**	13
Lead, as Pb (ug/l)	0.4	2	0	**	13

continued. . .

Parameter	Mean	Max	Min	S	N
Lithium, as Li (ug/l)	28	50	0	14	13
Manganese, as Mn (ug/l)	15	80	0	**	13
Mercury, as Hg (ug/l)	0.1	0.5	0	**	13
Nickel, as Ni (ug/l)	2	4	0	1	13
Strontium, as Sr (ug/l)	1300	2000	470	470	13
Zinc, as Zn (ug/l)	7	20	0	**	13

The water in Mountain Creek above Mountain Creek Lake exhibits some unusual quality problems. Four dissolved oxygen values were below 5.0 mg/l. This would constitute a stress on game fish in this watershed. Conductivity and total dissolved solids values were high when compared to other stream segments in the Dallas-Fort Worth 208 Area. Nutrients were relatively low. Chloride values appeared normal, but sulfate values were unusually high. Also, the water in Mountain Creek is very hard.

Sediment Analyses - No recent data for sediment pollutants in Mountain Creek Lake were encountered.

Biological
(10-1-74 through 6-30-76)

No recent biological data were encountered for Mountain Creek Lake.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Historical water analyses in Mountain Creek Lake have been conducted too infrequently to look for any trends that might exist.

Tributary Water Analyses - Prior to WY 1975, water analyses on Mountain Creek were conducted to infrequently to determine if any trends existed. However, it appears from the historical data available that sulfate has been high in the past, and some low dissolved oxygen values have occurred.

Sediment Analyses - No historical sediment pollutant analyses were encountered for Mountain Creek Lake.

Biological
(Prior to 10-1-74)

Fishes - Fullwood (1950) surveyed the fish of Mountain Creek Lake and Mountain Creek, primarily to assess the degree to which the fish community was infested with parasitic Copepoda. The results of his sampling are presented in Table No. XI. One parasitic Copepoda, *Lernaea* sp., was encountered out of 324 fish captured.

No other historical biological data were encountered for Mountain Creek Lake.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering Mountain Creek Lake. However, there exist one industrial point source and no domestic point sources within this watershed, according to TWQB (1975-1976).

WATER USES

Domestic and Municipal

Mountain Creek Lake is not used as a source of domestic and municipal water. According to present records, the lake is privately owned by Dallas Power and Light Company and there have been no permits issued authorizing water removal for domestic and municipal purposes.

Industrial

Mountain Creek Lake is heavily used as an industrial water source. The sole user of the water is Dallas Power and Light Company, who is authorized, according to NCTCOG (1974), to use 1.85 x 10^7 cubic meters (15,000 acre-feet) of water per year in a steam-electric generating plant. The water is used to cool steam condensing towers and an average of 0.14 cubic meters per second (3.2 MGD) is consumed by evaporation.

Agricultural

Mountain Creek Lake is not used as a source of agricultural water. According to present records, no water rights permits have been issued which authorize the removal of water from Mountain Creek Lake for agricultural purposes.

Recreation

Mountain Creek Lake is moderately used for recreation. Activities on the lake include fishing, boating, swimming, water skiing, and picnicking.

TABLE NO. XI

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR MOUNTAIN LAKE AND CREEK (SEGMENT 0805)

(Taken From Fullwood 1950)

Species	Number Captured	Size Range
Notropis lutrensis Plains red shiner	60	1¼"-3"
Ceratichthys vigilax (*Pimephales vigilax* (Baird & Girard)) Bullnose minnow (Bullhead minnow)	25	1"-3¼"
Opsopoeodus emiliae Pugnose minnow	10	1"-1½"
Campostoma anomalum Stoneroller	21	1½"-3¼"
Gambusia affinis Mosquitofish	25	1½"-2½"
Lepomis macrochirus Bluegill	11	1"-2½"
Lepomis megalotis Longear sunfish	26	1½"-3½"
Dorosoma cepedianum Gizzard shad	90	2"-5"
Ictaluris lacustris (*Ictalurus punctatus* (Rafinesque)) Southern channel catfish	15	1"-4"
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) Black bullhead	14	1½"-4¼"
Ameiurus natalis (*Ictalurus natalis* (Lesueur)) Yellow bullhead	20	2"-3½"
Pylodictis olivaris Flathead catfish	7	2¼"-2½"
TOTAL	324	

Note: Only one parasitic copepod, *Lernaea* sp. with eggs, was encountered. The parasite was found attached to the dorsal fin of a *Campostoma anomalum*.

SUMMARY

Data on Mountain Creek Lake were too scarce to assess the water quality of the lake. No water quality standards are in existence for Mountain Creek Lake. Also, few data were encountered for sediment or biological analyses within the lake.

Water quality data for Mountain Creek above Mountain Creek Lake revealed some problems with the parameters sulfate, dissolved oxygen, conductivity, total hardness, and total dissolved solids. Historical data were insufficient to determine the past status of these parameters.

ADDITIONAL DATA NEEDS

Though it is noted that there are insufficient data to assess in detail the relative nonpoint *vs*. point source loadings to Lake Worth and Benbrook Lake, neither are there noted any major or distinctive water quality problems in those lakes which would require such assessment. Therefore, no additional data for the assessment of nonpoint *vs*. point source loadings to Lake Worth or Benbrook Lake are required.

Regarding the assessment of historical trends in three lakes of Presentation Area A, Lake Arlington, Lake Worth, and Benbrook Lake, the present monitoring programs, plus the analyses which will forseeably be required on raw water withdrawn for drinking water supplies from all three of these lakes pursuant to the Safe Drinking Water Act, will be sufficient, and no additional data will be required.

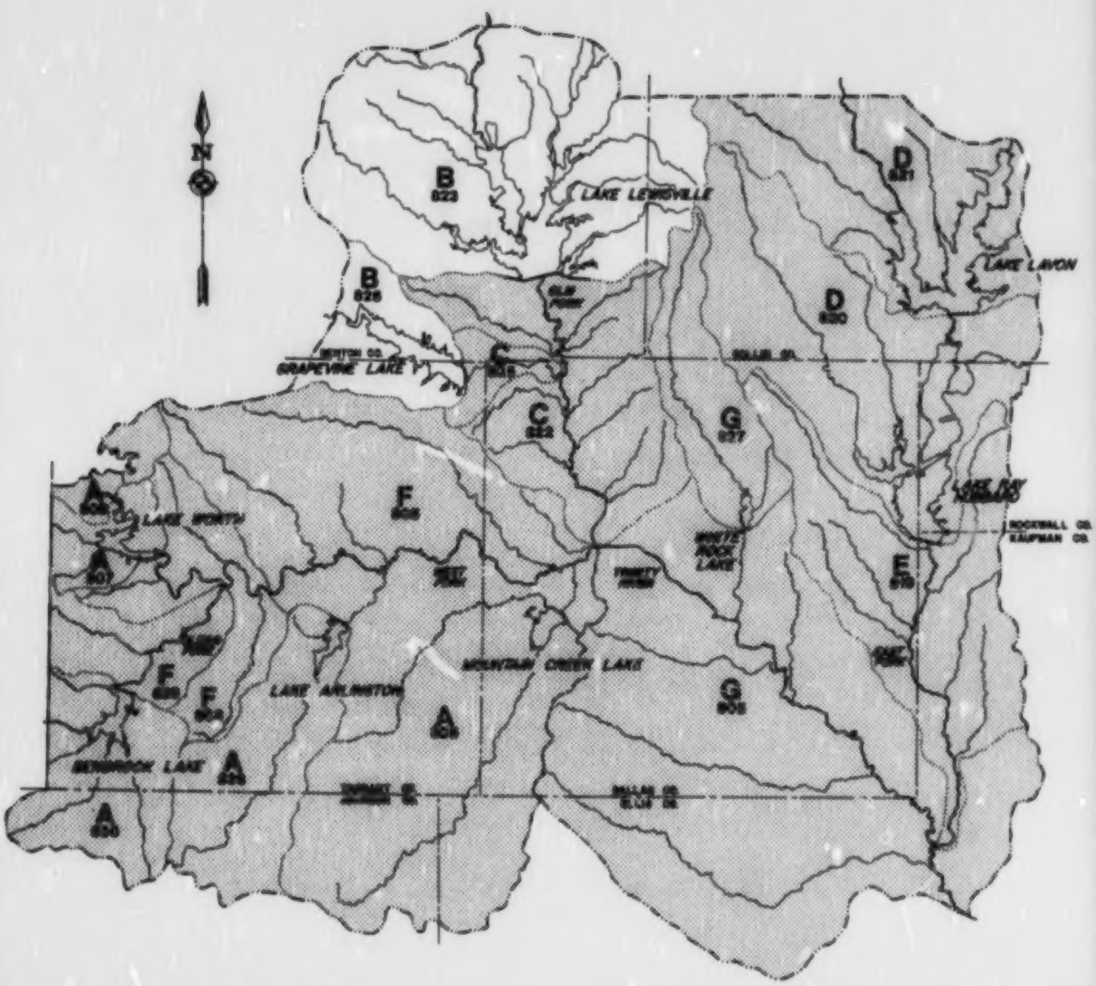
Regarding the assessment of point and nonpoint source loadings to Lake Arlington, there have been taste and odor problems which require such analysis. The City of Arlington and others have performed considerable analysis, indicating that point sources have been significant contributors to the problem. The point source discharges are, one by one, being diverted from the lake. Routine monitoring such as now exists will indicate the ultimate success of the diversions, and likewise the residual effect of nonpoint sources alone. If the problems persist, additional data would be required to further localize and isolate nonpoint sources. However, such additional data are not now required.

PRESENTATION AREA B

ELM FORK LAKES

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B
823
LAKE LEWISVILLE
B
826
DENTON CO.
GRAPEVINE LAKE
ELM FORK
C
C
822
COLLIN CO.
D
821
LAKE LAVON
D
820
G
827
LAKE RAY HUBBARD
ROCKWALL CO.
KAUFMAN CO.
A
LAKE WORTH
A
F
WEST FORK
TRINITY RIVER
WHITE ROCK LAKE
E
819
EAST FORK
F
F
LAKE ARLINGTON
MOUNTAIN CREEK LAKE
G
805
A
BENBROOK LAKE
A
A
TARRANT CO.
JOHNSON CO.
DALLAS CO.
ELLIS CO.

PRESENTATION AREA B - ELM FORK LAKES

SUMMARY

Water quality in both Lake Lewisville and Grapevine Lake appear to be generally good. Lake Lewisville has produced some high pH levels, as well as high phytoplankton counts. Available micronutrient and macronutrient data for both lakes appear to be high enough to support substantial phytoplankton communities. All TWQB (1976a) criteria were met.

Lake Lewisville, particularly, has a substantial amount of data on tributaries running into the reservoir. Many of these stations were upstream from the Dallas-Fort Worth 208 area. Data for Lake Lewisville tributaries indicate a moderate amount of suspended solids and nitrogen loading.

Sediment data, while being far from conclusive, indicate that Lake Lewisville sediments may act as a virtual "reservoir" for nutrients and many heavy metals. Sediments in both reservoirs appear to be heavily laden with nutrients, COD, and oil and grease. In addition PCB's were encountered at all three stations sampled in Lake Grapevine.

Biological data, where available, seem to indicate healthy conditions within the two lakes. Bacteria counts are well within standards. Occasional taste and odor problems result ostensibly from high phytoplankton populations in Lake Lewisville (see Figures C8 and C9, Segment 0822, Presentation Area C). Both Lake Lewisville and Grapevine Lake are known for a healthy game fish community.

Historical analyses of both chemical-physical and biological data often showed little change with time. Annual nutrient cycling takes place in both reservoirs due largely to stratification, but it is difficult to determine whether or not mean nutrient concentrations have increased over the years. Sufficient water quality data for analysis of trends go back to about 1972, the approximate time uncharacteristically high phytoplankton counts began showing up in Lake Lewisville. Before that time, water analyses were conducted approximately annually.

Figures B1 and B9 show enlarged maps of Segments 0823 and 0826, pinpointing existing monitoring stations.

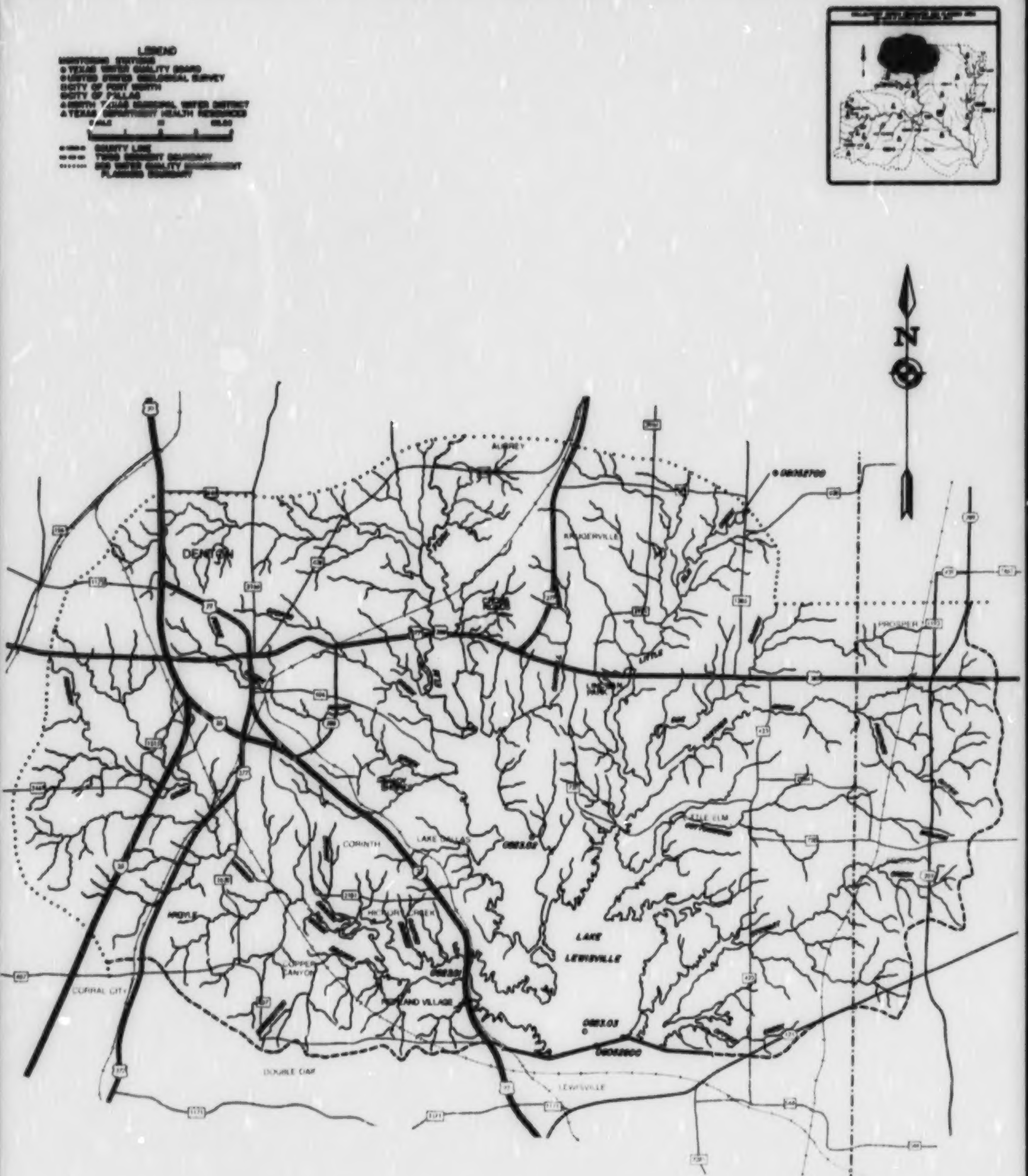
MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Segment 0823			
TWQB	Lake Lewisville at Hickory Cr. Arm	0823.01	CcBb
TWQB	Lake Lewisville at Elm Fork Arm	0823.02	Cd
TWQB	Lake Lewisville at midlake near dam	0823.03	Cd

continued. . .

Agency	Location	Station Number	Type of Record*
USGS	Little Elm Creek near Aubrey	08052700	DSp
USGS	Lake Lewisville near Lewisville	08052800	RQp
Segment 0826			
TWQB	Grapevine Lake near dam	0826.01	Cc
USGS	Grapevine Lake near Grapevine	08054500	QpR

*The "Type of Record" designations for each Agency are explained under Appendix A, Sources of Information.


LEGEND
MONITORING STATIONS
TEXAS WATER QUALITY BOARD
UNITED STATES GEOLOGICAL SURVEY
CITY OF FORT WORTH
CITY OF DALLAS
NORTH TEXAS REGIONAL WATER DISTRICT
TEXAS DEPARTMENT HEALTH RESOURCES
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
N
AUBREY
08052700
DENTON
KRUGERVILLE
PROSPER
LINCOLN PARK
LITTLE ELM
CORINTH
LAKE DALLAS
0823.02
ARGYLE
HICKORY CREEK
LAKE LEWISVILLE
COPPER CANYON
HIGHLAND VILLAGE
CORRAL CITY
0823.03
08052800
DOUBLE OAK
LEWISVILLE

PRESENTATION AREA B – Segment 0823

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE B1

LAKE LEWISVILLE (GARZA-LITTLE ELM RESERVOIR) - Segment 0823

Impoundment of water in Lake Lewisville began November 1, 1954, and first achievement of normal capacity was accomplished in April 1957. Lake Lewisville has a volume of 5.73 x 10^8 cubic meters (464,500 acre-feet) and covers an area of 94.2 square kilometers (23,280 acres). Prior to the completion of Lake Lewisville, Lake Dallas (approximately 35% of the surface area of Lake Lewisville) existed on what is now the Elm Fork Arm of Lake Lewisville. It should be noted that data collected prior to 1957 (i.e., data collected on Lake Dallas) will not be strictly comparable to data collected since that time.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Lake Lewisville (TWQB 0823.01, 0823.02, 0823.03; USGS 08052700). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	18.2	30.5	5.6	9.0	67
Dissolved Oxygen	9.8	12.3	6.5	1.6	68
pH (pH units)	8.3	9.0	7.7	0.2	68
Conductivity (umhos/cm)	371	477	265	50	68
Total Suspended Solids	22	72	3	**	19
Volatile Suspended Solids	6	13	0	**	20
Total Dissolved Solids	198	258	145	24	34
Ammonia, as N	0.06	0.20	0.00	**	40
Nitrate, as N	0.28	0.80	0.03	**	22
Nitrite + Nitrate, as N	0.10	0.25	0.02	**	21
Total Phosphate, as P	0.06	0.212	0.01	**	43
Orthophosphate, as P	0.04	0.114	0.008	**	20
Chloride, as Cl	37	102	15	17	37
Sulfate, as SO_4	31	39	16	5	35
Total Alkalinity, as $CaCO_3$	116	160	74	19	33
Carbonate Alkalinity, as $CaCO_3$	2	7	0	**	9
Chlorophyll a (ug/l)	8	28	3	**	20
Secchi (cm)	65.2	179.8	12.7	**	38
Fecal Coliform (#/100 ml)	12*	1000	0	**	14
Total Organic Carbon	6	10	2	3	6
Total Hardness, as $CaCO_3$	139	204	106	22	39
Noncarbonate Hardness, as $CaCO_3$	23	30	17	4	15
Chemical Oxygen Demand	16235	16235	16235	-	1
Sodium Absorption Ratio, SAR	0.8	0.8	0.8	-	1
Calcium, as Ca	45	55	38	6	15
Fluoride, as F	0.3	0.4	0.2	0.1	15
Iron, as Fe (ug/l)	25	70	0	**	21
Magnesium, as Mg	4.5	5.8	3.8	0.6	15
Manganese, as Mn (ug/l)	5	40	0	**	21
Potassium, as K	3.9	4.5	3.7	0.3	15

continued. . .

Parameter	Mean	Max	Min	S	N
Silica, as SiO_2	5.4	7.2	4.1	1.1	15
Sodium, as Na	23	32	20	4	15

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Lake Lewisville were taken from TWQB (1976a).

Temperature - Not to exceed 32.2 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable range: 7.0 - 9.0. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met (no reported values exceeded 500 mg/l).
Chloride - Mean concentration not to exceed 80 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 60 mg/l. Criterion met.
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

The data indicate consistently high dissolved oxygen concentrations in Lake Lewisville. This is a condition necessary for the maintenance of good game fish populations. Nutrient levels are sufficient to support high levels of phytoplankton, and, if conditions are right, algal blooms. The mean chlorophyll a concentration for the recent period was 8 ug/l, and the high concentration was 28 ug/l. Michalski and Conroy (1972) refer to "high" chlorophyll a concentrations of 10-15 ug/l as being associated with eutrophic conditions. Occasional high pH values appear to be associated with phytoplanktonic photosynthesis. However, none of the reported values were outside of the acceptable range.

Significant stratification occurs during the late summer. Nutrients settle out and become "trapped" in the hypolimnion, whereupon concentrations increase as the hypolimnion approaches anoxia (Figures B2 and B3). As fall overturn takes place, the soluble phosphorus and the reduced nitrogen are resuspended and available to algae. It is at this time of year, late September - early October, that surface nutrient concentrations are highest.

Tributary Water Analyses - Tributaries entering into Lake Lewisville and actually comprising part of Segment 0823 include Office Creek, Stewart Creek, Cottonwood Branch, Panther Creek, Doe Branch, Little Elm Creek, Cantrell Slough, Elm Fork Trinity River, Cooper Creek, Pecan Creek, Carter Branch, Bryant Branch, Hickory Creek, and Poindexter Branch. The USGS reports bimonthly water quality data for the Elm Fork

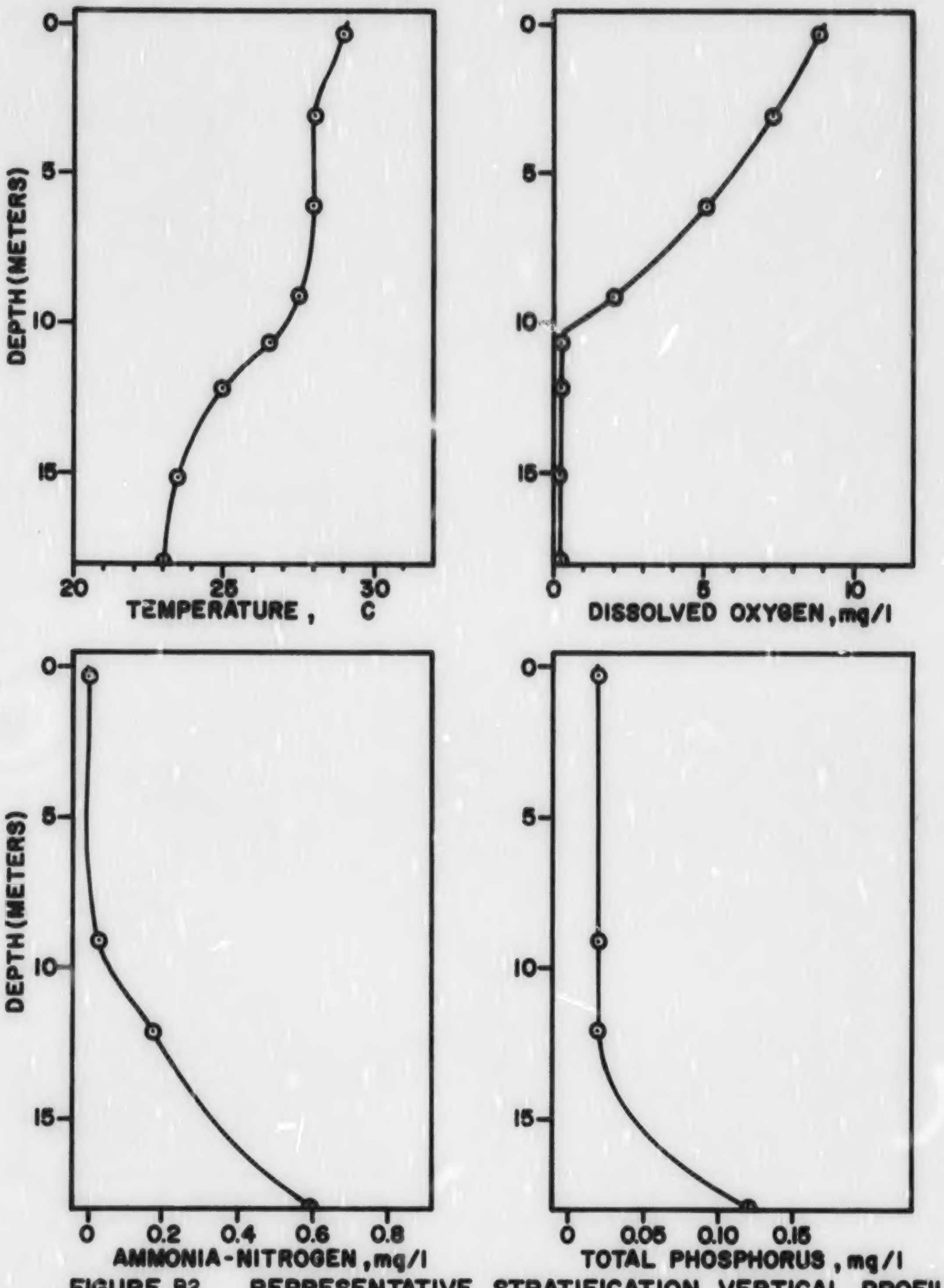


FIGURE B2. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN LAKE LEWISVILLE (USGS STATION A_c) FOR TEMPERATURE, DISSOLVED OXYGEN, AMMONIA, AND TOTAL PHOSPHORUS ON SEPTEMBER 4, 1975 (TIME 1120).
(DATA FROM USGS 1971-1976 b)

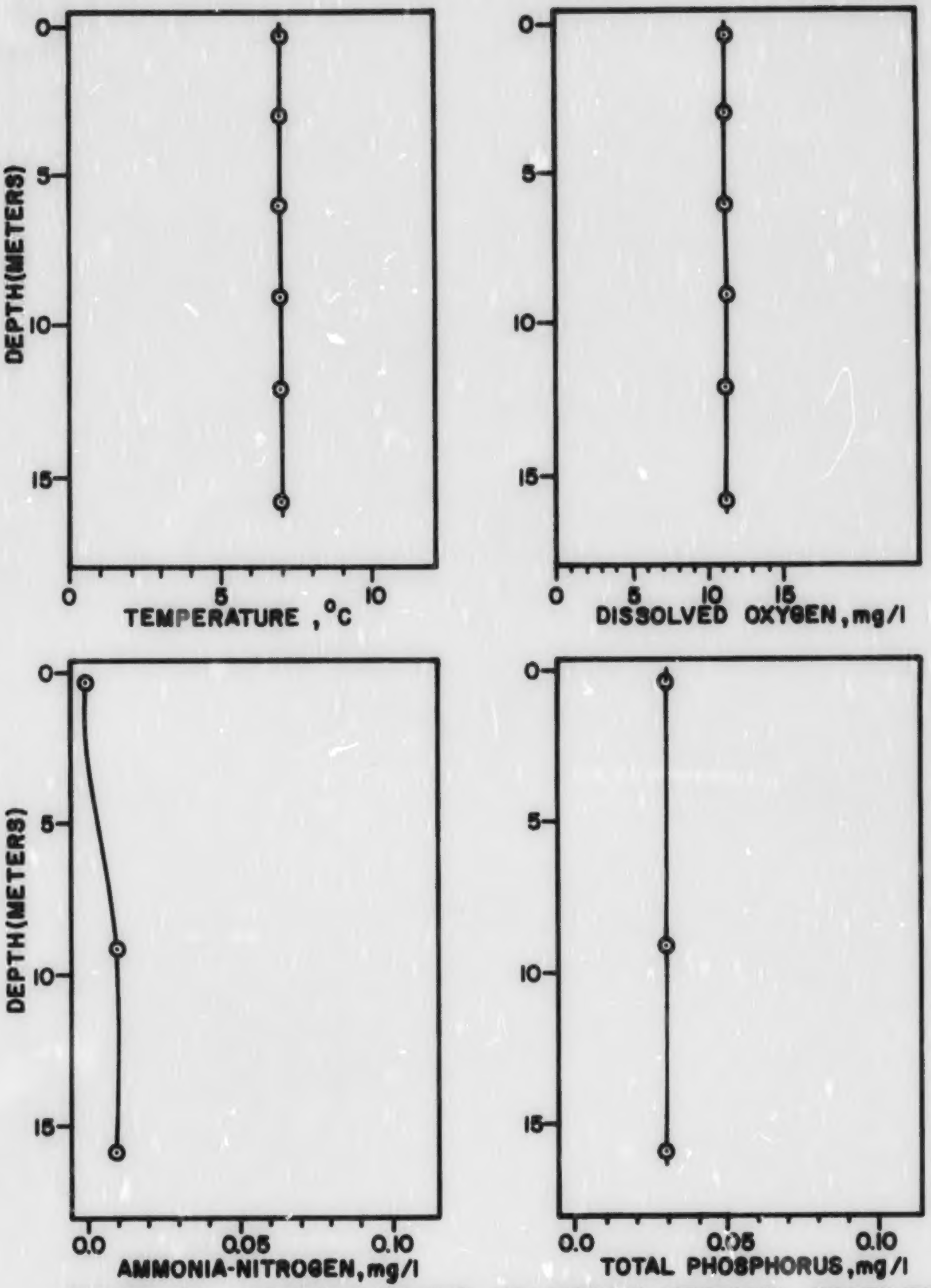


FIGURE B3. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN LAKE LEWISVILLE (USGS STATION Ac) FOR TEMPERATURE, DISSOLVED OXYGEN, AMMONIA, AND TOTAL PHOSPHORUS ON JANUARY 28, 1976.

(DATA FROM USGS 1971-1976 b)

near Sanger (08050500). Also, the USGS reports discharge, total suspended sediment, temperature, and conductivity for two stations on Little Elm Creek and one station on Clear Creek. Only one of these stations is located in the Dallas-Fort Worth 208 area, however. The following data summary (for WY 1975) is for Little Elm Creek near Aubrey (USGS 08052700).

Parameter	Mean	Max	Min	S	N
Discharge (m^3/sec)	2.6	131.4	0	**	365
Temperature (C)	16.3	30.5	5.5	7.3	106
Conductivity (umhos/cm)	405	677	181	116	129
TSS (mg/l)	118	1350	14	**	298

**Data from a clearly non-normal distribution; standard deviation not calculated.

Sediment Analyses - Lake Lewisville (TWQB 0823.01, 0823.02). All concentrations are in mg/kg (dry weight basis), unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Oil and Grease	323	323	323	-	1
Organic Nitrogen	665	665	665	-	1
Phosphorus in Particulates	100	200	1	-	2
Arsenic, As	1.62	2.47	0.77	-	2
Barium, Ba	89	96	82	-	2
Boron, B	20.9	41.8	0.05	-	2
Cadmium, Cd	0.32	0.57	0.08	-	2
Chromium (total), Cr	19.1	22.9	15.3	-	2
Copper, Cu	4.5	7.8	1.2	-	2
Lead, Pb	9.0	16.1	1.9	-	2
Manganese, Mn	190	292	88.8	-	2
Mercury, Hg (mg/kg, wet weight)	41.0	82.0	0.0	-	2
Nickel, Ni	9.4	13.9	4.9	-	2
Selenium, Se	0.04	0.08	0.0	-	2
Silver, Ag	0.67	0.74	0.60	-	2
Zinc, Zn	19.2	30.2	8.2	-	2

-Standard deviation is not calculated when N is less than six.

Biological
(10-1-74 through 6-30-76)

Bacteria - The only bacteria data encountered were fecal coliform counts (TWQB, 1972-1976). These data were presented and comparisons to standards were made in the WATER ANALYSES section. The available data indicated a maximum count of 1000 organisms/100 ml and a logarithmic mean of just 12 organisms/100 ml. No other bacteria data were encountered.

Plankton - No recent data on phytoplankton counts or identification were discovered. Chlorophyll a concentrations are presented in the WATER ANALYSES section. The City of Dallas conducts phytoplankton counts and generic identification on samples taken at the Lake Lewisville outlet works. These data will be covered in the section on Segment 0822 in Presentation Area C.

Aquatic Vegetation - According to TPWD (1976a), no aquatic vegetation problem exists in Lake Lewisville. Table No. XII lists aquatic macrophytes present as well as approximate areal coverage of each.

Macroinvertebrates - No existing monitoring programs sample benthic organisms in Lake Lewisville. No information on benthic organisms was found for Segment 0823.

Fishes - TPWD (1976a) conducted a fish survey on Lake Lewisville covering most of 1975. Techniques used included frame netting, gill netting, seining, and cove rotenoning.

The important sport fishes were listed as channel catfish, white bass, white crappie, largemouth bass, and several species of sunfish. The introduced walleye and striped bass hybrids were not considered important sport fishes.

Table No. XIII lists the fish species encountered during the survey, along with numbers captured.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Figure B4 shows historical trends from existing data for three parameters: nitrate-nitrogen, dissolved oxygen, and conductivity. In particular, nitrate and dissolved oxygen show little trend. Conductivity exhibits what may be a trend, although data are not abundant enough to be certain.

Other parameters showed little or no trend with time. Water quality in Lake Lewisville appears to have remained relatively constant, at least over the last five years. Data for the period 1957 (first achievement of normal capacity) through 1971 are less available than more recent data.

Welch (1939) investigated nutrient influence on algal populations for Lake Dallas (predecessor to Lake Lewisville). However, he in no way conducted a detailed analysis of the chemical quality of the water. No other theses or miscellaneous sources of water quality data on Lake Lewisville (or Lake Dallas) were encountered.

TABLE NO. XII

RESULTS OF VEGETATIVE SURVEY, LAKE LEWISVILLE, AUGUST 1975

(Taken from TPWD 1976a)

Vegetation	% of Lake Surface Occupied	Total Area Occupied (Acres)	General Location
Buttonbush *Cephalanthus occidentalis*	<1	5	Sparcely found along entire shoreline
Sedge *Cyperus* sp.	<1	<1	
Loosestrife *Decodon verticillatus*	<1	<1	
Rush *Juncus* sp.	<1	<1	
Cottonwood *Populus deltoides*	<1	14	Along 12% shoreline, upper end mostly
Pondweed *Potomogeton americanus*	<1	2	Back of coves, lower end
Arrowhead *Sagittaria graminea*	<1	<1	
Willow *Salix niger*	<1	36	Along 36% of shoreline over entire lake
Bullrush *Scirpus* sp.	<1	<1	

TABLE NO. XIII

SUMMARY OF TPWD (1976a) FISH SURVEY OF LAKE LEWISVILLE, CONDUCTED DURING 1975

	COLLECTION METHOD			
	Gill Net	Seine	Frame Net	Rotenone
Species	No.	No.	No.	No. Per Acre
GAME FISH				
Channel catfish	40	112	2	75.2
White bass	22	232	15	16.6
Green sunfish	-	1	1	7.6
Warmouth	-	2	3	4.7
Orangespotted sunfish	-	12	-	32.3
Bluegill	-	25	64	60.4
Longear sunfish	-	102	23	335.8
Redear sunfish	-	3	-	-
Spotted bass	-	6	-	-
Largemouth bass	2	19	-	33.9
White crappie	27	50	307	7.9
ROUGH FISH				
Gizzard shad	35	384	77	694.0
Carp	3	2	1	18.7
River carpsucker	6	3	17	8.2
Smallmouth buffalo	21	1	33	4.2
Bigmouth buffalo	-	1	-	-
Spotted sucker	-	1	-	-
Freshwater drum	23	24	25	298.7
Spotted gar	2	-	-	1.8
Longnose gar	3	-	-	-
Shortnose gar	-	-	-	0.2
Yellow bullhead	-	-	1	0.2
Black bullhead	-	-	2	-
FORAGE FISH				
Threadfin shad	-	1594	37	677.0
Plains minnow	-		-	-
Golden shiner	-	-	-	6.4
Pugnose minnow	-	1	-	0.4
Red shiner	-	741	-	10.5
Mimic shiner	-	1	-	-
Bullhead minnow	-	861	-	500.2
Misquitofish	-	7	-	12.5
Mississippi silverside	-	1357	-	18.1
Logperch	-	36	-	23.8
TOTALS	184	5588	608	2852.3

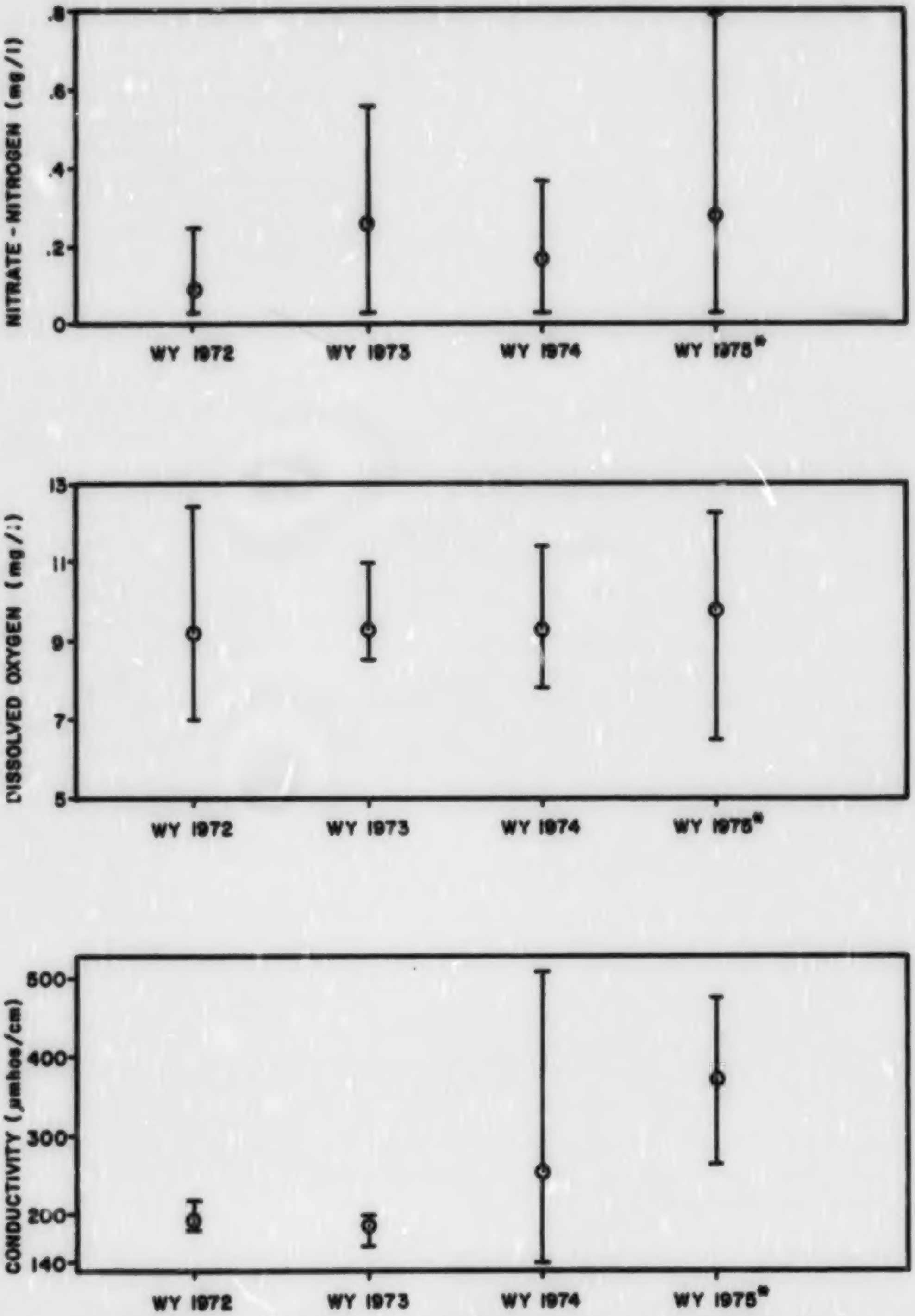


FIGURE B4. HISTORICAL DATA TRENDS EXHIBITED BY NITRATE - NITROGEN, DISSOLVED OXYGEN, AND CONDUCTIVITY FOR LAKE LEWISVILLE (Segment 0823)

DATA PLOTTED ARE MEAN VALUES AND RANGES.

(DATA FROM USGS 1971-1976, TWQB 1972-1976)

* WATER YEAR 1975 + DATA THROUGH JUNE 30, 1976

Tributary Water Analyses - The City of Dallas has conducted water analyses on tributaries to Lake Lewisville since 1960. The tributaries sampled include Clear Creek, Pecan Creek, upper Elm Fork, Hickory Creek, and Little Elm Creek. Analyses performed include alkalinity, total hardness, solids, and minerals. Figure B5 presents historical trends in chloride, total alkalinity, and total hardness for Clear Creek at FM 428. The period covered is 1963 through 1972. It can be inferred from the graphs that chloride and total hardness (principally calcium and magnesium) concentrations were greatly affected by oil field pollution in 1963. In addition, all three parameters show the infuence of flow variations. Data for Pecan Creek, Hickory Creek, and Little Elm Creek on the parameters total alkalinity and total hardness for the 1960's revealed much the same trend as Clear Creek. Chloride concentrations, however, for these three creeks do not approach levels encountered in Clear Creek.

Figure B6 presents historical trends (1969-1972) for chloride, total alkalinity, and total hardness for the Elm Fork at US 380. It may be noticed that all three parameters are high relative to other tributaries entering Lake Lewisville. Given the greater flow carried by the upper Elm Fork, it is evident that the greatest loads of these parameters are contributed to Lake Lewisville by the upper Elm Fork.

The USGS has collected water quality data on tributaries to Lake Lewisville regularly since 1968, with some analyses conducted since 1966. The USGS stations are as follows: Clear Creek near Sanger (08051500), Little Elm Creek near Celina (08052650), and Little Elm Creek near Aubrey (08052700). Only Little Elm Creek near Aubrey is within the Dallas-Fort Worth 208 area. Data are collected on four parameters: discharge, suspended sediment, temperature, and conductivity. Figure B7 shows historical trends in discharge and suspended sediment for Little Elm Creek near Aubrey. Temperature and conductivity data were comprised of partial records, and any attempt to derive a trend for each of these with time would produce questionable results.

Cook (1946) conducted qualitative and quantitative studies of the bacterial populations of Pecan Creek with particular emphasis on the natural purification processes of the creek as it recovered from the City of Denton STP. Organisms studied included Eberthella, Salmonella, and Shigella.

Sediment Analyses - Hendricks and Silvey (1973) reported ranges in sediment nutrient concentrations as follows: Kjeldahl nitrogen from 0.22 to 4.05 mg/g, organic carbon from 1.10 to 22.20 mg/g, and phosphates (hydrolyzable) from 0.13 to 0.77 mg/g.

TWQB (1974a) reports the following sediment pollutant concentrations for Lake Lewisville. All concentrations are in mg/kg, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Chemical Oxygen Demand	39900	53410	9940	-	5
Kjeldahl Nitrogen	1500	1990	510	-	5

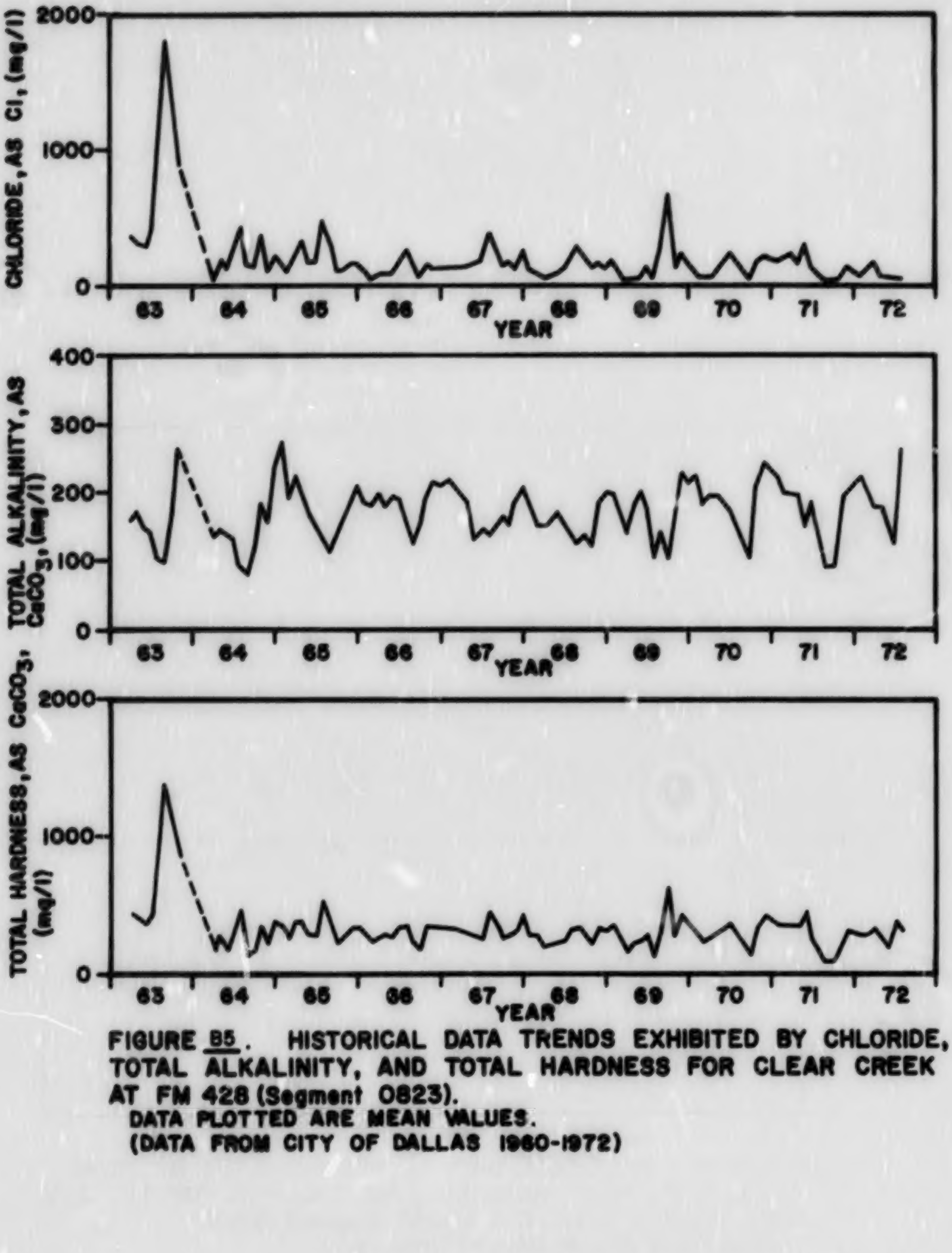


FIGURE B5. HISTORICAL DATA TRENDS EXHIBITED BY CHLORIDE, TOTAL ALKALINITY, AND TOTAL HARDNESS FOR CLEAR CREEK AT FM 428 (Segment 0823).
DATA PLOTTED ARE MEAN VALUES.
(DATA FROM CITY OF DALLAS 1960-1972)

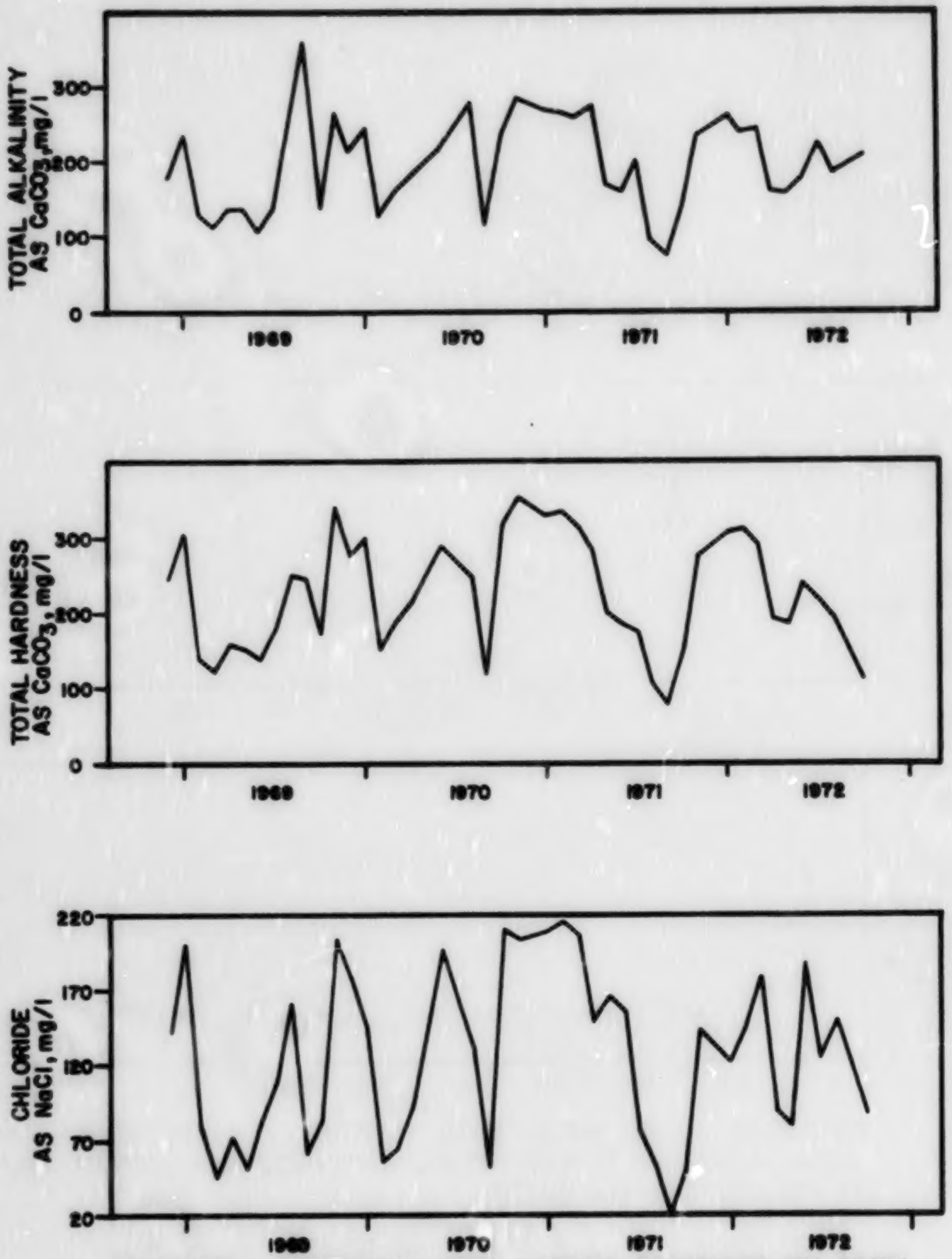


FIGURE 86. HISTORICAL DATA TRENDS EXHIBITED BY TOTAL ALKALINITY, TOTAL HARDNESS, AND CHLORIDE FOR THE ELM FORK TRINITY RIVER AT U.S. 380 (Segment 0823)
(DATA FROM CITY OF DALLAS 1968-1972)

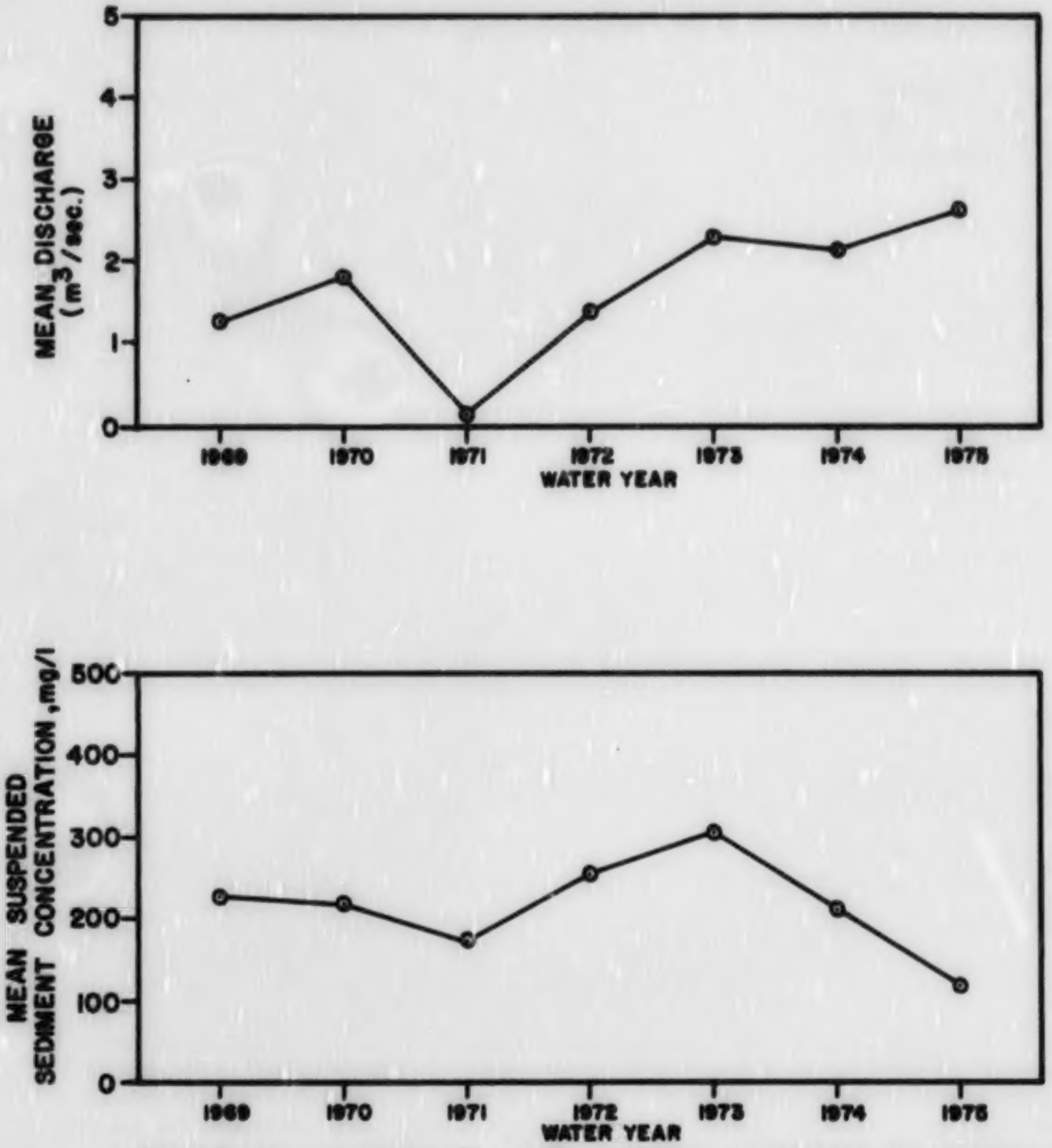


FIGURE B7. HISTORICAL DATA TRENDS EXHIBITED BY DISCHARGE AND SUSPENDED SEDIMENT FOR LITTLE ELM CREEK NEAR AUBREY (USGS 08052700)(Segment 0823)
(DATA FROM USGS 1971-1976)

continued. . .

Parameter	Mean	Max	Min	S	N
Oil and Grease	70	210	10	-	5
Total Phosphate	2300	2700	1600	-	5
Volatile Solids (%)	4.5	5.7	1.6	-	5
Aldrin (ug/kg)	0.0	0.0	0.0	-	5
Chlordane (ug/kg)	0.0	0.0	0.0	-	5
DDD (ug/kg)	0.2	0.3	0.0	-	5
DDE (ug/kg)	0.5	0.9	0.2	-	5
DDT (ug/kg)	0.0	0.0	0.0	-	5
Diazinon (ug/kg)	0.0	0.0	0.0	-	5
Dieldrin (ug/kg)	0.0	0.0	0.0	-	5
Endrin (ug/kg)	0.0	0.0	0.0	-	5
Heptachlor (ug/kg)	0.0	0.0	0.0	-	5
Heptachlor Epoxide (ug/kg)	0.0	0.0	0.0	-	5
Lindane (ug/kg)	0.0	0.0	0.0	-	5
Methoxychlor (ug/kg)	0.0	0.0	0.0	-	5
Methyl Parathion (ug/kg)	0.0	0.0	0.0	-	5
Parathion (ug/kg)	0.0	0.0	0.0	-	5
Silvex (ug/kg)	0.0	0.0	0.0	-	5
Toxaphene (ug/kg)	0.0	0.0	0.0	-	5
PCB (ug/kg)	0.0	0.0	0.0	-	5
Arsenic, as As	12	16	8.8	-	5
Cadmium, as Cd	1	1	1	-	5
Copper, as Cu	23	27	16	-	5
Chromium, as Cr	38	44	29	-	5
Lead, as Pb	26	48	12	-	5
Manganese, as Mn	750	1050	450	-	5
Mercury, as Hg	0.07	0.10	0.02	-	5
Nickel, as Ni	32	34	26	-	5
Silver, as Ag	1	2	1	-	5
Zinc, as Zn	61	71	44	-	5

-Standard deviation not computed when N is less than six.

Biological
(Prior to 10-1-74)

Bacteria - Only one source was encountered which dealt with historical bacteria analyses in Segment 0823. Foster (1937) conducted counts and identifications of Colon-Aerogenes (sic) bacteria (probably Aerobacter aerogenes and Escherichia coli) from samples taken in Lake Dallas (predecessor to Lake Lewisville). No other sources were found.

Plankton - Several sources provide historical phytoplankton data: Evans (1936), Bagwell (1938), and Brooks (1940). Again, these studies were conducted on Lake Dallas, which was considerably smaller than Lake Lewisville.

Evans (1936) studied phytoplankton density as a function of depth. Similarly, Bagwell (1938) conducted phytoplankton enumerations at each two meters in depth in Lake Dallas. He also noted a phytoplankton bloom in July consisting largely of a single species, *Melosira crenulata*. Brooks (1940) noted an increase in phytoplankton numbers during the month of June in Lake Dallas.

No historical phytoplankton data were discovered for the period 1957 through 1974 (i.e., for Lake Lewisville), with the exception of those data discussed in the section on Segment 0822.

Aquatic Vegetation - As previously mentioned, Lake Lewisville has had no history of problems with aquatic macrophytes (TPWD 1972, 1976a). Table No. XII lists aquatic macrophyte species present in the lake during August 1975. No prior vegetation lists were available.

Macroinvertebrates - Flook (1970) surveyed the Metazoan parasites afflicting Unionid bivalves in Lake Lewisville, but provided no actual quantification of the bivalves present.

Table No. XIV presents a list of benthic macroinvertebrates reported for the upper Elm Fork Trinity River at FM 428 by Ryckman, *et al*. (1974). The data indicate a fairly diverse community of macroinvertebrates.

Fishes - Lake Lewisville has been the subject of numerous fish surveys (TPWD 1970, 1972, 1973, 1976a). The most recent report (TPWD 1976a) fails to make any observations regarding piscine succession in Lake Lewisville. Figure B8, however, shows trends in fish community structure for Lake Lewisville for the period 1969-1975. The percentage of rough fish seems to show a slight decline, while the percentage of game fish seems to show a slight increase. At present, rough fish appear to comprise approximately 70%, by weight, of the community while game fish comprise only about 30%. By numbers, both constitute about half of the community.

One reason for the increase in proportion of game fish in Lake Lewisville may be game fish stocking undertaken in the past. In 1969, Lake Lewisville was stocked with 604,875 largemouth bass and 177,600 channel catfish. In 1971, the lake was stocked with an additional 21,000 largemouth bass, and in 1972, it was stocked with 405,000 walleye. Very few of the walleye have been taken in samples since their stocking in 1972.

NONPOINT VS. POINT SOURCE LOADINGS

According to EPA (1976b), the annual total nitrogen and total phosphorus loadings to Lake Lewisville are 1.047 x 10^6 kilograms per year and 1.171 x 10^6 kilograms per year respectively. The Elm Fork of the Trinity River was reported to contribute 27.4% of the total nitrogen

TABLE NO. XIV

BENTHIC MACROINVERTEBRATES
UPPER ELM FORK @ F.M. 428
(TAKEN FROM RYCKMAN, ET AL. 1974)

	ORGANISM ABUNDANCE*		
Macroinvertebrate Species		Date	
	3/73	7/73	2/74
Hydropsyche orris	13	a	53
Cheumatopsyche campyla	5	a	
Rhyacophila sp.			3
Isogenus sp.			3
Pteronarcella sp.	4	p	
Baetis sp.			12
Caenis sp.	2	a	
Neocloeon alamance	2	p	
Habrophlebia sp.	8	p	14
Isonychia sp.	1		5
Stenonema heterotarsale		a	5
Stenonema luteum			17
Plathemis lydia	1	p-a	
Anomalagrion hastatum	1		
Agrion maculatum	1	p	
Stenelmis sp.	3	a	
Elophila	2	p	
Tendipes tetans	32	p	
Glyptotendipes senilis	15	p	
Pseudochironomus fulviventris	17	p	
Musculium transversum		p	

*plates and hand picked
a = abundant
p = present

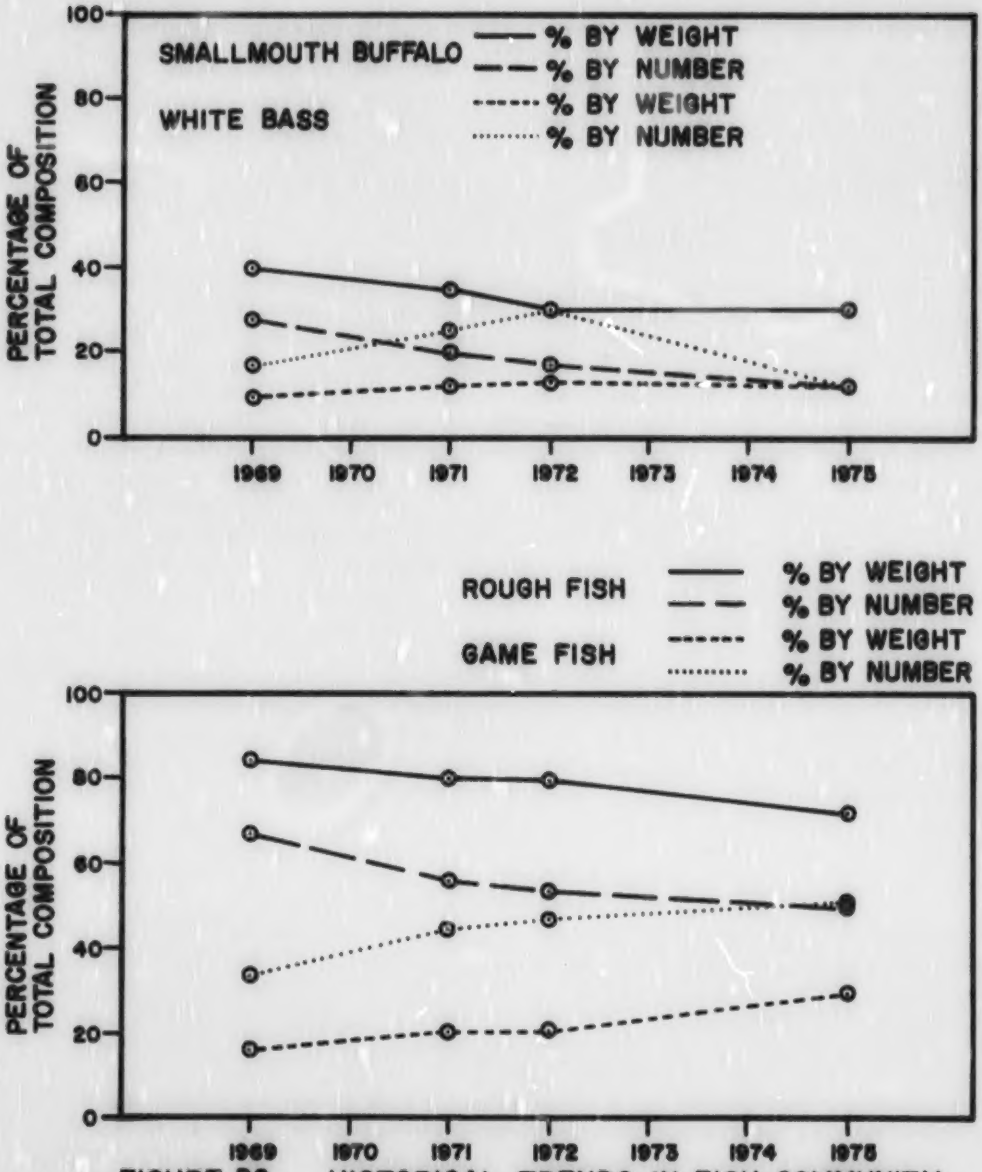


FIGURE B8. HISTORICAL TRENDS IN FISH COMMUNITY STRUCTURE FOR LAKE LEWISVILLE (Segment 0823). SAMPLING DONE WITH GILL NET (DATA FROM TPWD 1970-1976 a)

load and 29.7% of the total phosphorus load to Lake Lewisville. Local point source discharges (9) contribute 16.9% of the total nitrogen load and 29.1% of the total phosphorus load to Lake Lewisville.

Net annual accumulations of total nitrogen and total phosphorus in Lake Lewisville, as reported by EPA (1976b), are 5.28×10^5 kilograms and 8.01×10^4 kilograms respectively.

WATER USES

Domestic and Municipal

Lake Lewisville is very heavily used as a source of domestic and municipal water. The primary user of the water is the City of Dallas whose water rights permits entitle them to 95% of the water. The City of Denton has the rights to the remaining 5% of the water. The diversions for the City of Denton are made via an intake structure on the lake. Dallas' share of the water is released, as needed, to the Elm Fork channel, where it flows by gravity to downstream diversion points. Water rights permits for domestic and municipal withdrawals from this segment total 5.25×10^8 cubic meters per year (426,000 acre-feet per year). According to NCTCOG (1974), the dependable yield of this lake is estimated to be 4.22 cubic meters per second (95.4 MGD).

Industrial

Lake Lewisville is little used for an industrial water source. The primary user for this purpose is the City of Dallas, which has 4.93×10^6 cubic meters per year (4,000 acre-feet per year) allocated for industrial uses in its water rights permit, according to NCTCOG (1974).

Agricultural

According to NCTCOG (1974), there is no official authorization to use the waters of Lake Lewisville as an agricultural water supply.

Recreational

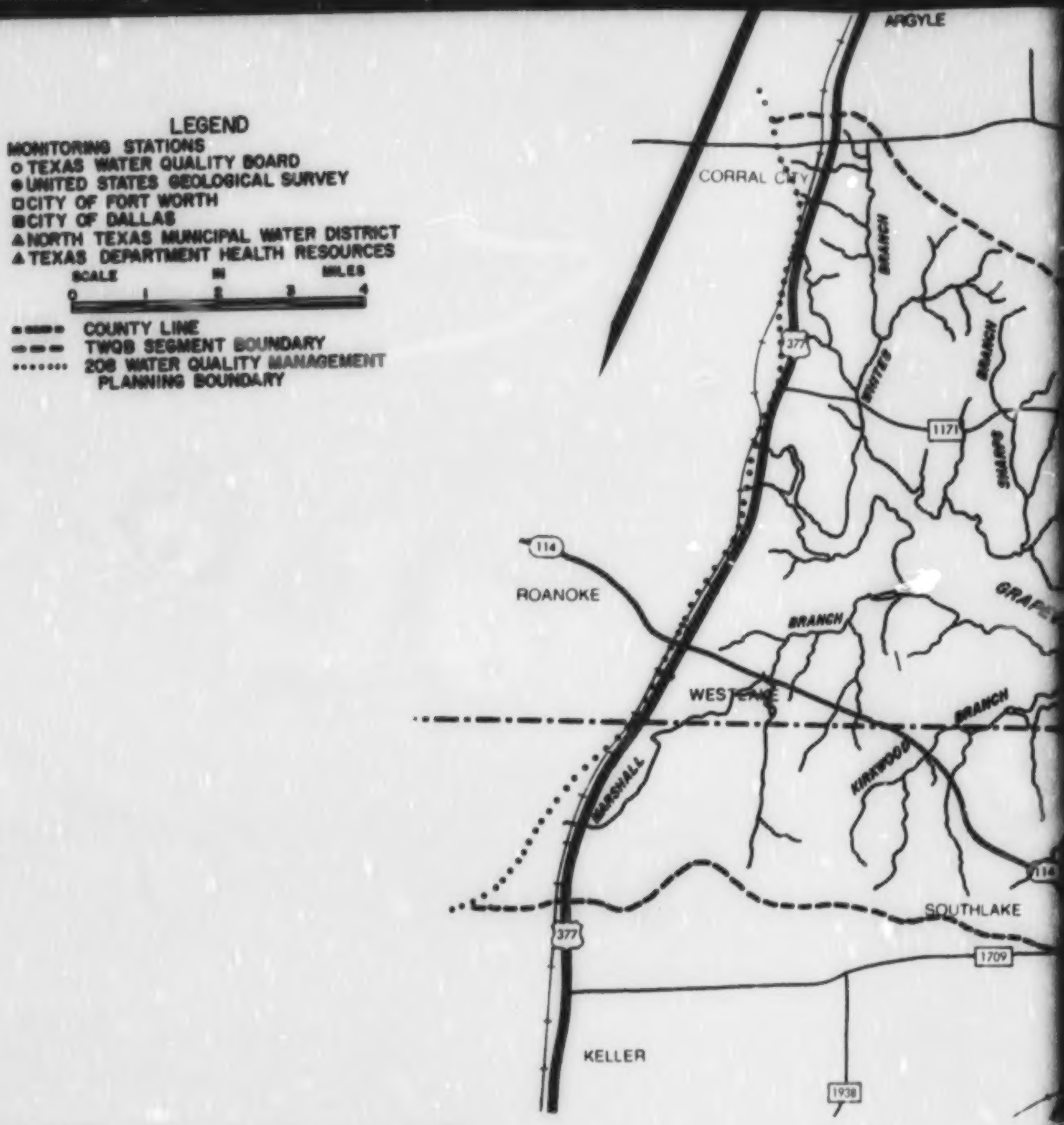
Lake Lewisville, much the same as all other area reservoirs, is heavily used for recreation. Activities engaged in on and around the lake include boating, hiking, swimming, camping, fishing, hunting, and water skiing.

SUMMARY

Water quality in Lake Lewisville, according to recent available data, is good. All of the TWQB (1976a) criteria were met. Nutrient concentrations are moderately high and chlorophyll a values indicate some eutrophic symptoms. In addition Lake Lewisville undergoes a considerable degree of summer stratification. Historical water quality in the lake appears to have been quite good, with the exception of high chloride concentrations in the mid-1950's, resulting from water being imported from the Red River.

Lake Lewisville tributaries have been studied extensively over the years. Much water quality information has been provided, and little problem seems to exist other than occasional high chloride concentrations from oil field runoff.

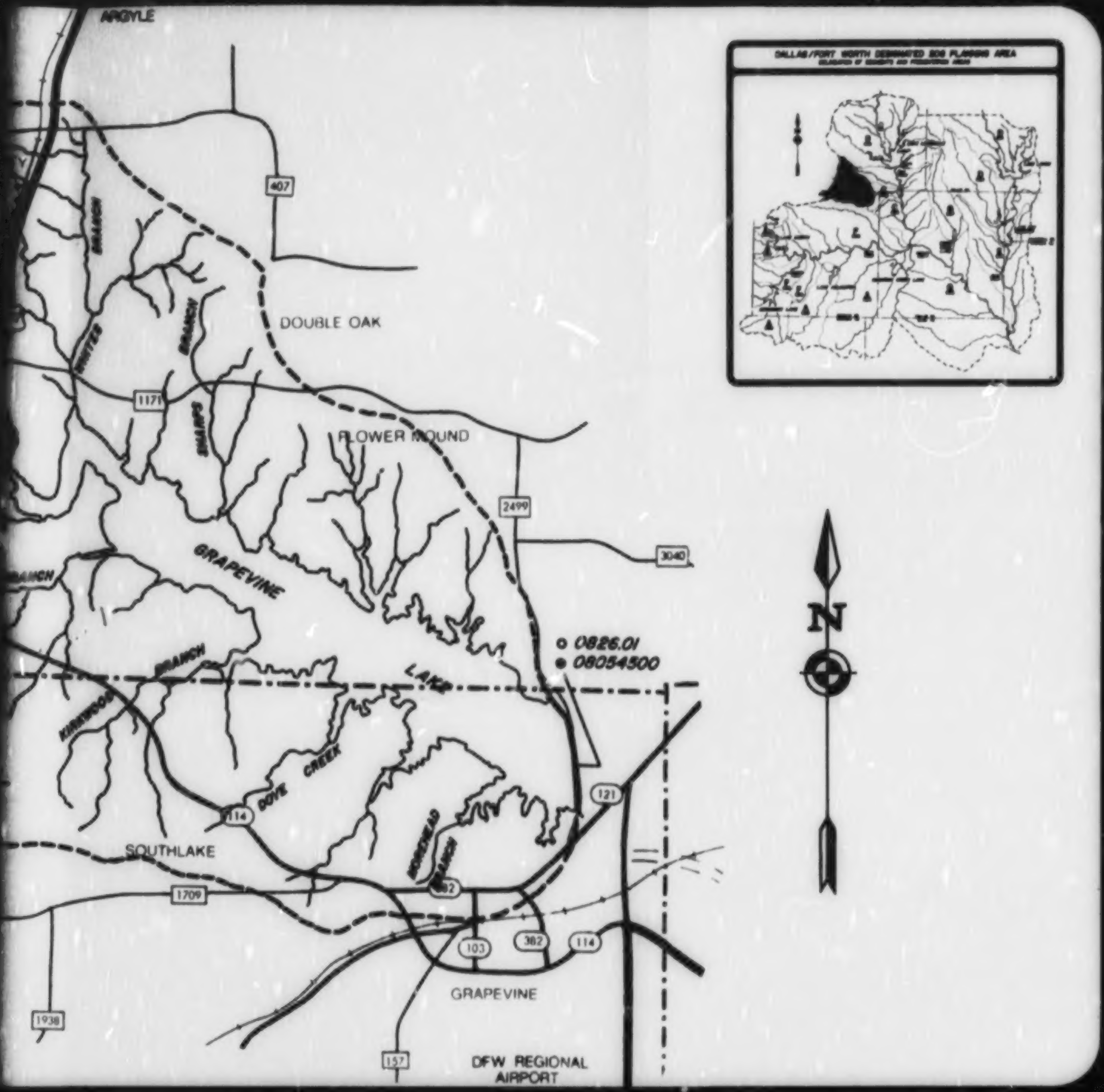
A substantial amount of biological data, particularly on phytoplankton and fishes, have been produced for Lake Lewisville. High phytoplankton counts and a large proportion of rough fish appear to be the general rule.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
▲ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
ARGYLE
CORRAL CITY
377
BRANCH
WHITES
BRANCH
1171
SHARPS
114
ROANOKE
GRAPE
BRANCH
WESTLAKE
BRANCH
KIRKWOOD
MARSHALL
114
SOUTHLAKE
377
1709
KELLER
1938

PRESENTATION AREA B - Segment 0826

TRINITY RIVER AUTHORITY OF T

Planning and Environmental Managemen


ARGYLE
407
DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA
DOUBLE OAK
BRANCH
WHITES
BRANCH
1171
FLOWER MOUND
2499
3040
GRAPEVINE
BRANCH
N
0826.01
08054500
BRANCH
KIRKWOOD
LAKE
DOVE CREEK
121
114
MOREHEAD
BRANCH
SOUTHLAKE
382
1709
103
382
114
GRAPEVINE
1938
157
DFW REGIONAL
AIRPORT

RITY OF TEXAS December 1976
Management Division FIGURE B9

GRAPEVINE LAKE - Segment 0826

Grapevine Lake was constructed during the period 1948-1952, with normal capacity first acheived in May 1957. Grapevine Lake has a conservation storage capacity of 2.33 x 10^8 cubic meters (188,550 acre-feet), covering an area of 29.9 square kilometers (7,380 acres). The mean depth of the reservoir is about 7.8 meters (25.5 feet), and it has a drainage area of 1800 square kilometers (695 square miles).

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Grapevine Lake (TWQB 0826.01; USGS 08054500). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.9	27.0	10.0	6.1	7
Dissolved Oxygen	9.4	13.4	7.0	1.9	11
pH (pH units)	8.0	8.6	7.5	0.4	12
Conductivity (umhos/cm)	222	358	160	50	12
Total Suspended Solids	13	21	10	5	7
Volatile Suspended Solids	7	10	1	**	7
Total Dissolved Solids	198	198	198	-	1
Ammonia, as N	0.1	0.1	0.1	0.0	7
Nitrate, as N	0.07	0.03	0.15	**	7
Total Phosphate, as P	0.033	0.075	0.01	**	7
Orthophosphate, as P	0.020	0.065	0.00	**	7
Chloride, as Cl	22	25	19	2	8
Chloride, as Cl	22	25	19	2	8
Sulfate, as SO_4	33	42	16	9	8
Total Hardness, as $CaCO_3$	140	140	140	-	1
Noncarbonate Hardness, as $CaCO_3$	16	16	16	-	1
Chlorophyll a (ug/l)	4	4	4	0	7
Fecal Coliform (#/100 ml)	57*	130	23	**	6
Total Organic Carbon	9	12	5	-	3
Turbidity (JTU)	28	100	0	**	11
Sodium Absorption Ratio, SAR	0.7	0.7	0.7	-	1
Bicarbonate, as HCO_3	145	145	145	-	1
Carbonate, as CO_3	0	0	0	-	1
Calcium, as Ca	44	44	44	-	1
Fluoride, as F	0.1	0.1	0.1	-	1
Magnesium, as Mg	6.1	6.1	6.1	-	1
Potassium, as K	3.5	3.5	3.5	-	1
Silica, as SiO_2	7.3	7.3	7.3	-	1
Sodium, as Na	18	18	18	-	1

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Grapevine Lake were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH- Acceptable range: 7.0 - 9.0 Criterion met
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met (no reported values in excess of 500 mg/l).
Chloride - Mean concentration not to exceed 80 mg/l. Criterion met (no reported values in excess of 80 mg/l).
Sulfate - Mean concentration not to exceed 60 mg/l. Criterion met (no reported values in excess of 60 mg/l).
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Typical summer and winter vertical profiles for Grapevine Lake are presented in Figures B10 and B11. Parameters graphed are temperature, dissolved oxygen, and pH. All three parameters show significant stratification patterns. The surface-to-bottom temperature difference is about 9 °C. Also, in this instance, near-anoxic conditions occur below a depth of ten meters.

Tributary Water Analyses - Water which drains into Grapevine Lake comes from Denton Creek, Sharps Branch, Whites Branch, Marshall Branch, Kirkwood Branch, Dove Creek, and Morehead Branch. No data were available for any of these small tributaries. Similarly, no data were available for upper Denton Creek, with the exception of Denton Creek near Justin (USGS 08053500). This station is not within the Dallas-Fort Worth 208 area, and the only water quality data produced are for temperature and suspended sediment.

Sediment Analyses - The following table summarizes recent sediment data for Grapevine Lake as reported by TWQB (1976b). All concentrations are mg/kg, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Chemical Oxygen Demand	42700	46000	36700	-	3
Kjeldahl Nitrogen	1510	1790	1250	-	3
Oil and Grease	440	840	180	-	3
Total Phosphate	1700	2200	1300	-	3
Volatile Solids (%)	7.9	9.4	6.5	-	3
Arsenic, as As	5.2	5.8	4.3	-	3
Cadmium, as Cd	< 0.5	< 0.5	< 0.5	-	3
Copper, as Cu	14	17	11	-	3
Chromium, as Cr	32	40	21	-	3
Lead, as Pb	25	36	15	-	3
Manganese, as Mn	670	850	530	-	3
Mercury, as Hg	0.04	0.05	0.03	-	3
Nickel, as Ni	24	28	17	-	3
Silver, as Ag	1.1	1.4	0.9	-	3
Zinc, as Zn	50	59	42	-	3
Silvex (ug/kg)	0.0	0.0	0.0	-	3

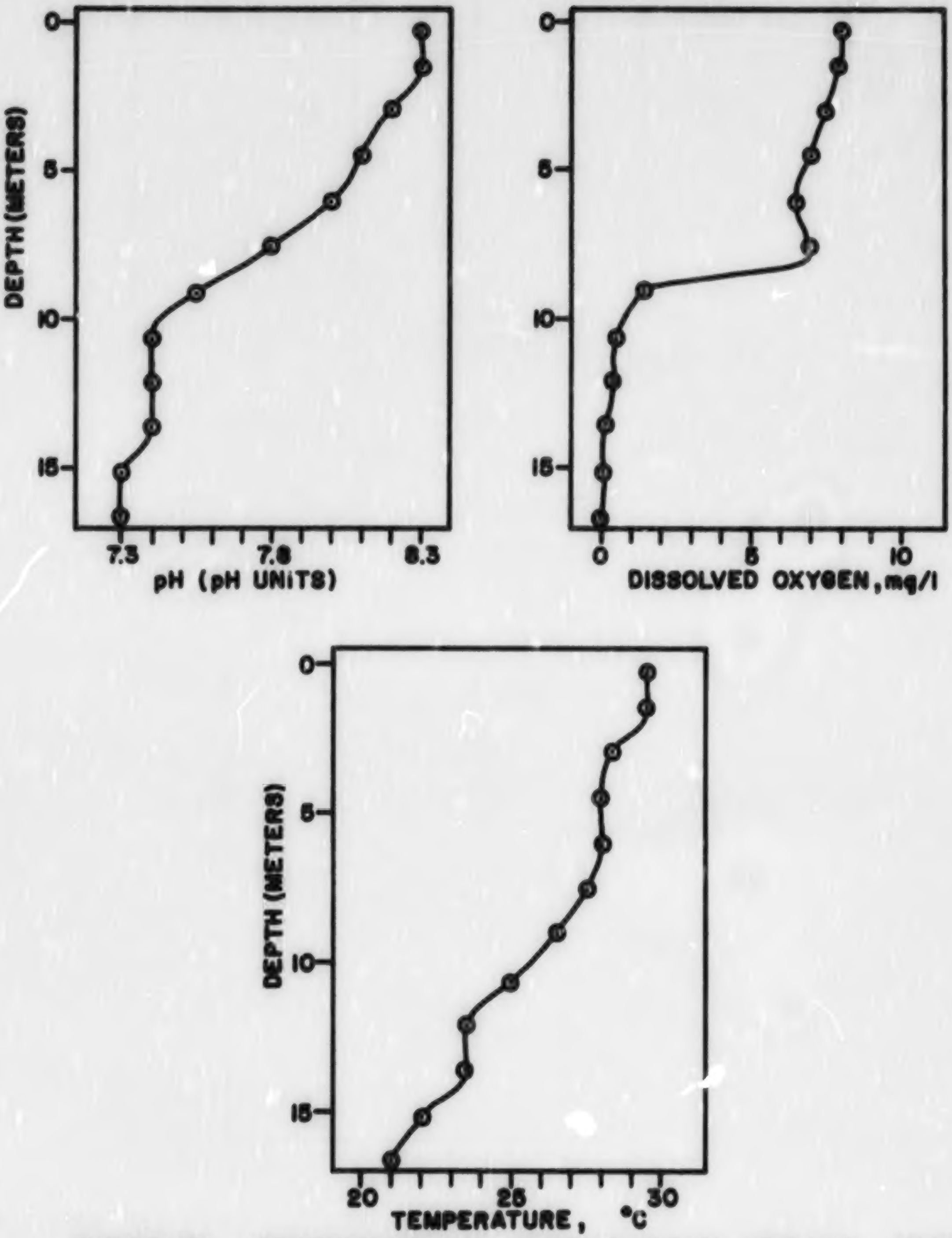


FIGURE B10. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN LAKE GRAPEVINE FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON JULY 22, 1975 (TIME 1300).
(DATA FROM TWQB 0826.01)

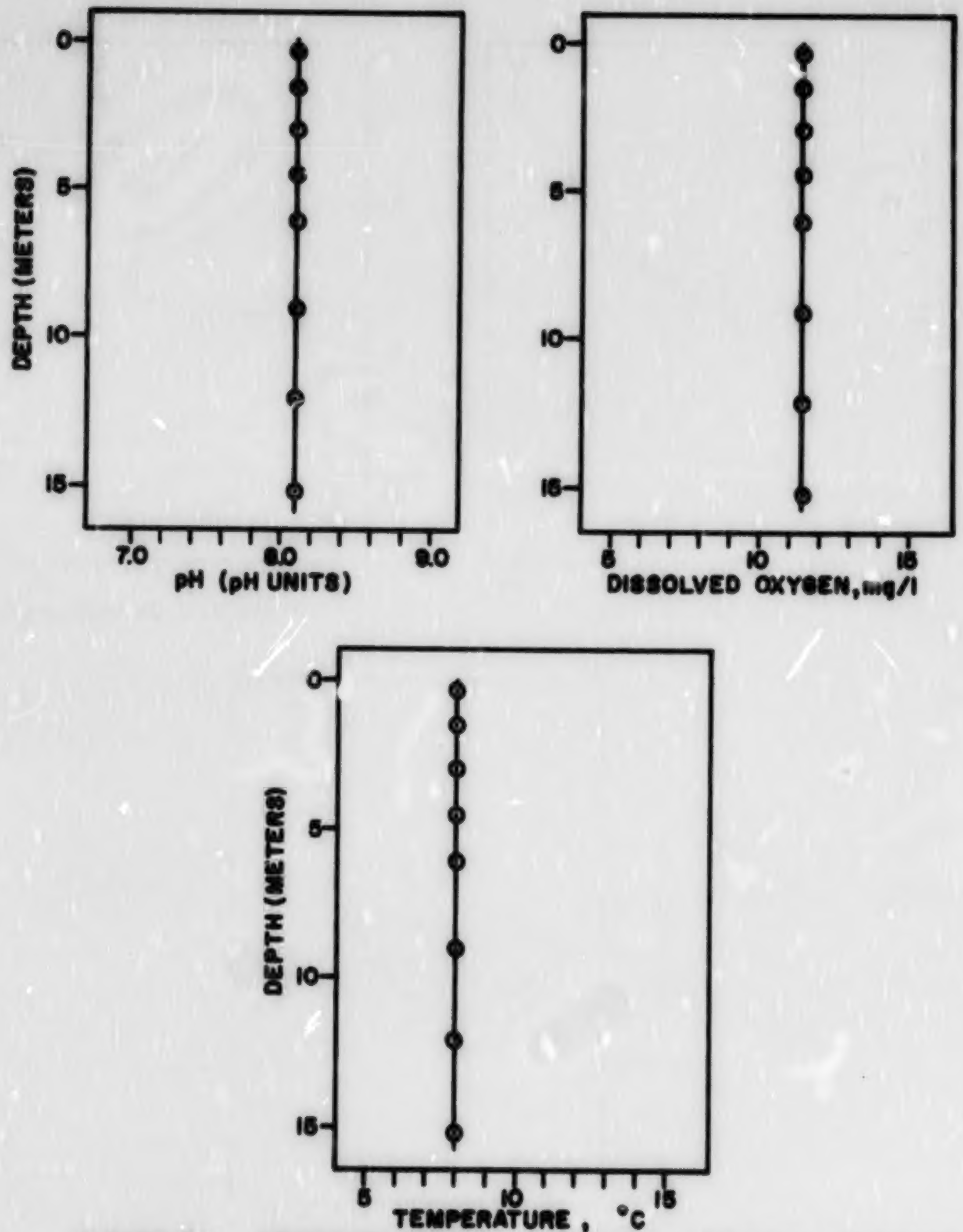


FIGURE B11. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN LAKE GRAPEVINE FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON FEBRUARY 2, 1976 (TIME 0940).
(DATA FROM TWQB 0826.01)

continued. . .

Parameter	Mean	Max	Min	S	N
Aldrin (ug/kg)	0.0	0.0	0.0	-	3
Chlordane (ug/kg)	0.0	0.0	0.0	-	3
DDD (ug/kg)	0.0	0.0	0.0	-	3
DDE (ug/kg)	0.0	0.0	0.0	-	3
DDT (ug/kg)	0.0	0.0	0.0	-	3
Diazinon (ug/kg)	0.0	0.0	0.0	-	3
Dieldrin (ug/kg)	0.0	0.0	0.0	-	3
Endrin (ug/kg)	0.0	0.0	0.0	-	3
Heptachlor (ug/kg)	0.0	0.0	0.0	-	3
Heptachlor Epoxide (ug/kg)	0.0	0.0	0.0	-	3
Lindane (ug/kg)	0.0	0.0	0.0	-	3
Methoxychlor (ug/kg)	0.0	0.0	0.0	-	3
Methyl Parathion (ug/kg)	0.0	0.0	0.0	-	3
Parathion (ug/kg)	0.0	0.0	0.0	-	3
Toxaphene (ug/kg)	0.0	0.0	0.0	-	3
PCB (ug/kg)	15.0	17.0	11.0	-	3

Biological
(10-1-74 through 6-30-76)

Bacteria - All of the available recent bacterial data were presented in the WATER ANALYSES section. The logarithmic mean for the fecal coliform count was 57 organisms/100 ml. This is well below the established maximum for segment 0826 of 200 organisms/100 ml. The maximum reported fecal coliform count was 130 organisms/100 ml, and the minimum reported count was 23 organisms/100 ml.

Plankton - No recent data were encountered for Grapevine Lake regarding phytoplankton or zooplankton.

Aquatic Vegetation - No recent aquatic vegetation surveys for Grapevine Lake were encountered. Grapevine Lake, however, has had no history of problems with aquatic macrophytes.

Macroinvertebrates - A large *Corbicula* sp. population exists around the island in Grapevine Lake (TRA 1976b). No other macroinvertebrate data were encountered for Grapevine Lake.

Fishes - No recent fish surveys have been conducted on Grapevine Lake by the TPWD.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Insufficient data exist for a trend analysis of water quality constituents in Grapevine Lake. All data produced so far have indicated good water quality. In general, dissolved oxygen values have been high, nutrient concentrations relatively low, and chlorophyll a and suspended solids concentrations have been relatively low.

Tributary Water Analyses - No historical water quality data were encountered for tributaries entering Grapevine Lake.

Sediment Analyses - No historical sediment pollutant analyses were available for Grapevine Lake.

Biological
(Prior to 10-1-74)

Bacteria - No historical bacteria data were encountered for Grapevine Lake.

Plankton - The City of Dallas conducted a phytoplankton survey of Grapevine Lake on October 29, 1971. The results of this survey are presented in Table No. XV. Over 73% of the algae reported were diatoms.

Aquatic Vegetation - No historical macrophyte surveys were encountered for Grapevine Lake.

Macroinvertebrates - No historical macroinvertebrate data were encountered.

Fishes - Table No. XVI presents the results of TPWD fish surveys conducted from 1960-1963. It can be seen that rough fish made up 61.6% (by number) of the fish community, with gizzard shad comprising 36.4% (by number) of the total in 1960-1963; however, game fish provide 57.9% (by number) of the community, with white bass comprising 36.8% (by number) of the total. No fish surveys for Grapevine Lake were encountered for the period 1964 to the present.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering Grapevine Lake. However, there are presently no industrial and three domestic point sources within this watershed.

TABLE NO. XV
ALGAE GENERA COLLECTED ON OCTOBER 29, 1971 IN GRAPEVINE LAKE (SEGMENT 0826)
(TAKEN FROM CITY OF DALLAS 1971)

Organism	No. per ml	%
DIATOMS		
Synedra sp.	136	23.9
Cyclotella sp.	48	8.5
Fragilaria sp.	168	29.6
Navicula sp.	16	2.8
Diatoma sp.	48	8.5
Total Diatoms	416	73.2
GREEN ALGAE		
Pediastrum sp.	8	1.4
Coelastrum sp.	16	2.8
Chlorella sp.	16	2.8
Treubaria sp.	8	1.4
Ankistrodesmus sp.	32	5.6
Chlorococcum sp.	8	1.4
Total Green Algae	88	15.5
BLUE-GREEN ALGAE		
Oscillatoria sp.	16	2.8
Anabaena sp.	8	1.4
Total Blue-Green Algae	24	4.2
MISCELLANEOUS ALGAE		
Euglena sp.	16	2.8
Trachelomonas sp.	24	4.2
Total Miscellaneous Algae	40	7.0
TOTAL ALGAE	568	100.0

TABLE NO. XVI

FISHES COLLECTED IN LAKE GRAPEVINE (SEGMENT 0826)
(TAKEN FROM TPWD 1964)

	1960-1961				1962-1963			
Fish	**No.**	**%**	**Kg.**	**%**	**No.**	**%**	**Kg.**	**%**
ROUGH FISH								
Spotted gar	2	3.03	2.3	10.22	1	2.63	0.4	2.73
Shortnose gar	4	6.06	1.3	5.61	-	-	-	-
Longnose gar	1	1.51	1.0	4.61	-	-	-	-
Gizzard shad	24	36.36	3.8	16.83	4	10.52	0.7	4.71
Smallmouth buffalo	3	4.55	4.1	18.04	1	2.63	2.4	15.73
River carpsucker	5	7.58	4.4	19.63	2	5.24	1.7	11.26
Drum	1	1.51	0.2	0.81	1	2.63	0.1	0.61
Carp	-	-	-	-	7	18.42	5.0	33.19
ROUGH FISH TOTALS	40	60.60	17.1	75.75	16	42.07	10.3	68.23
GAME FISH								
Channel catfish	1	1.51	0.5	2.21	-	-	-	-
Largemouth bass	2	3.03	0.6	2.80	4	10.52	1.2	8.02
White crappie	23	34.86	4.4	19.24	4	10.52	0.6	3.66
White bass	-	-	-	-	14	36.84	3.1	20.45
GAME FISH TOTALS	26	39.40	5.5	24.25	22	57.88	4.9	32.13
TOTALS	66	100.00	22.6	100.00	38	99.95	15.2	100.36

WATER USES

Domestic and Municipal

Grapevine Lake is moderately used for domestic and municipal water supplies. The primary users are the City of Dallas, Park Cities Municipal Utilities District, and the City of Grapevine. Water rights permits for domestic and municipal withdrawals from this segment total 1.68×10^8 cubic meters (136,250 acre-feet) per year. The dependable yield from this lake, according to TWDB (1977), totals 1.08 cubic meters per second (24.7 MGD).

Industrial

There are no official permits issued authorizing the removal of water from Grapevine Lake for industrial purposes according to NCTCOG (1974). However, some of the water removed for domestic and municipal use is utilized in local industries in both Dallas and Grapevine.

Agricultural

According to NCTCOG (1974), the waters of Grapevine Lake are not used as an agricultural water supply.

Recreational

Grapevine Lake is heavily used as a source of local recreation. Activities which are popular at the lake include boating, fishing, picnicking, water skiing, and hiking.

Navigational

Grapevine Lake is a Corps of Engineers project which was developed for water conservation, flood control, and navigation. According to NCTCOG (1974), 15.5% of the water conservation pool may be used for navigational purposes. Up until now, all of the withdrawals from Grapevine Lake have been for domestic and municipal use, but in the event that it is needed, the percentage (15.5%) equals 3.08×10^7 cubic meters (25,000 acre-feet) water per year.

SUMMARY

Grapevine Lake water quality appears to be quite good. All of the TWQB (1976a) criteria were met. Nutrients appeared to be relatively low and chlorophyll _a_ values were all low. Significant summer stratification occurs in Grapevine Lake, as it does in most of the lakes in the Dallas-Fort Worth 208 Area.

Very little historical data exist for Grapevine Lake. Biological data are also quite scarce. Some historical fish surveys indicate an apparent predominance of rough fish species.

ADDITIONAL DATA NEEDS

Lake Lewisville existing monitoring programs, if maintained, will provide an adequate determination of trends in the future. However, a substantial effort of the type now underway on Lake Ray Hubbard should be conducted within the next few years on Lake Lewisville because 1) there are large and growing point sources in the lake watershed, including the greater Denton area and substantial lakeshore development, 2) these same developing areas have associated urban-area nonpoint sources, 3) there is a large and agriculturally important rural area in the watershed, 4) the lake is a major source of drinking water, and 5) there is a demonstrated potential for eutrophication problems in the lake, though they have not been major or chronic to date.

Regarding Grapevine Lake, though the historical data are too limited for analysis of water quality trends, the current quality is good, and a continuation of current monitoring programs will be sufficient to determine future trends in the lake. Notwithstanding the limited data base, one can attribute the great majority of loading to the lake to nonpoint sources because there are so few and such small point sources in the watershed, and no additional data are required to distinquish point from nonpoint sources. However, there is one site upstream of the lake on Denton Creek (actually outside of the designated 208 area) upon which additional routine water quality monitoring would be beneficial in distinguishing nonpoint sources in the immediate lake area (including the most urbanized or developing areas of the watershed) from nonpoint sources in the predominently rural remainder of the Denton Creek watershed. This additional monitoring should be done at the present USGS flow gage on Denton Creek at FM 156 near Justin. There was very limited USGS water quality monitoring there from 1966 to 1975, then discontinued.

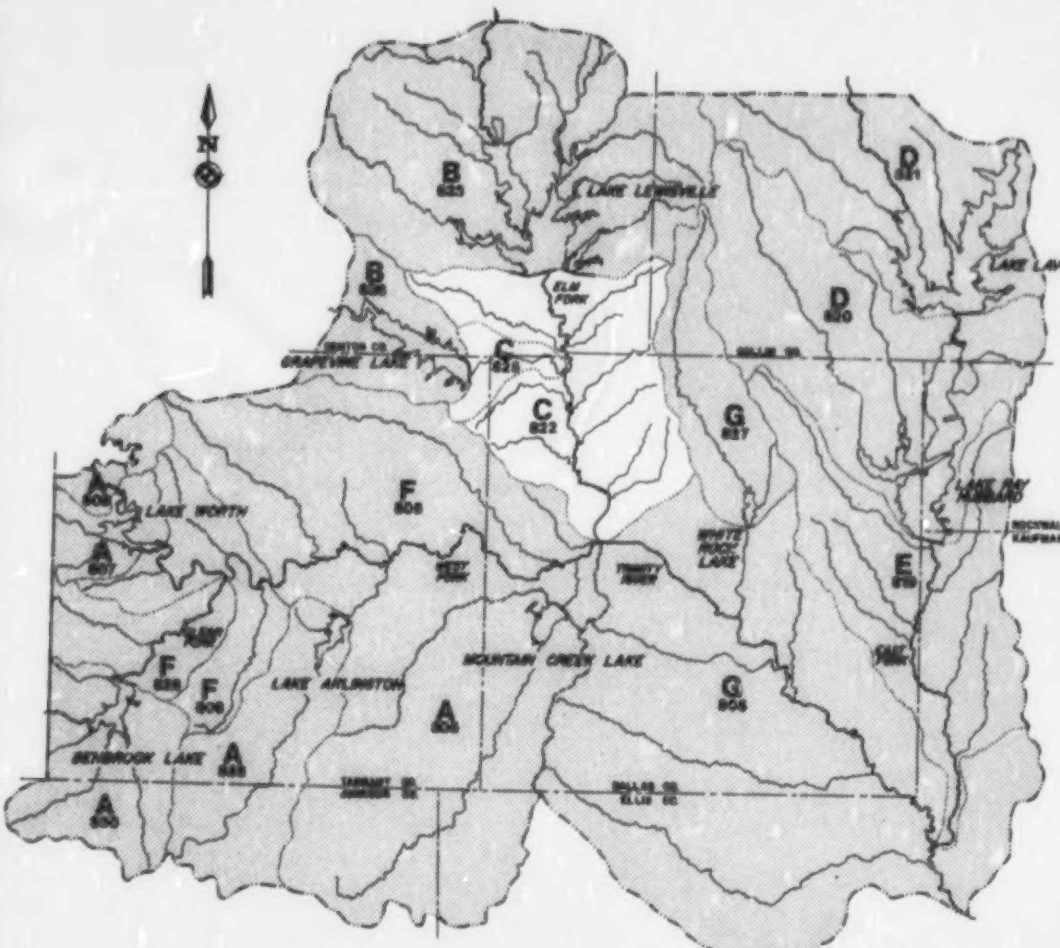
From a biological standpoint, it would be desirable to have a comprehensive fish survey conducted on Grapevine Lake to assess the relative proportions of rough and game fish species.

PRESENTATION AREA C

ELM FORK BELOW LAKES

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B
823
LAKE LEWISVILLE
D
LAKE LAVON
B
ELM FORK
D
820
C
DENTON CO.
GRAPEVINE LAKE
DALLAS CO.
C
822
G
827
A
F
806
LAKE WORTH
A
LAKE RAY HUBBARD
ROCKWALL CO.
KAUFMAN CO.
WEST FORK
TRINITY RIVER
WHITE ROCK LAKE
E
F
F
LAKE ARLINGTON
MOUNTAIN CREEK LAKE
A
G
805
EAST FORK
BENBROOK LAKE
A
TARRANT CO.
JOHNSON CO.
DALLAS CO.
ELLIS CO.
A

PRESENTATION AREA C - ELM FORK BELOW LAKES

SUMMARY

Both the lower Elm Fork (Segment 0822) and Denton Creek (Segment 0825) have relatively good water quality. The only problem with TWQB (1976a) standards was with regard to fecal coliform concentrations on the Elm Fork, which did exceed the standard slightly.

Water from the Elm Fork is used by the City of Dallas for drinking water. Denton Creek enters the Elm Fork upstream from the sites where Dallas pumps off water for treatment and drinking, so that essentially waters from both segments become drinking water. Both segments contain water that is moderately hard to hard.

Both the Elm Fork and Denton Creek have come to support relatively larger phytoplankton communities within the last four years. The reason for this is not clear since there has seemingly been little change in the total nutrient composition of the water.

Figures C1 and C11 show enlarged maps of Segments 0822 and 0825, respectively, pinpointing existing monitoring stations.

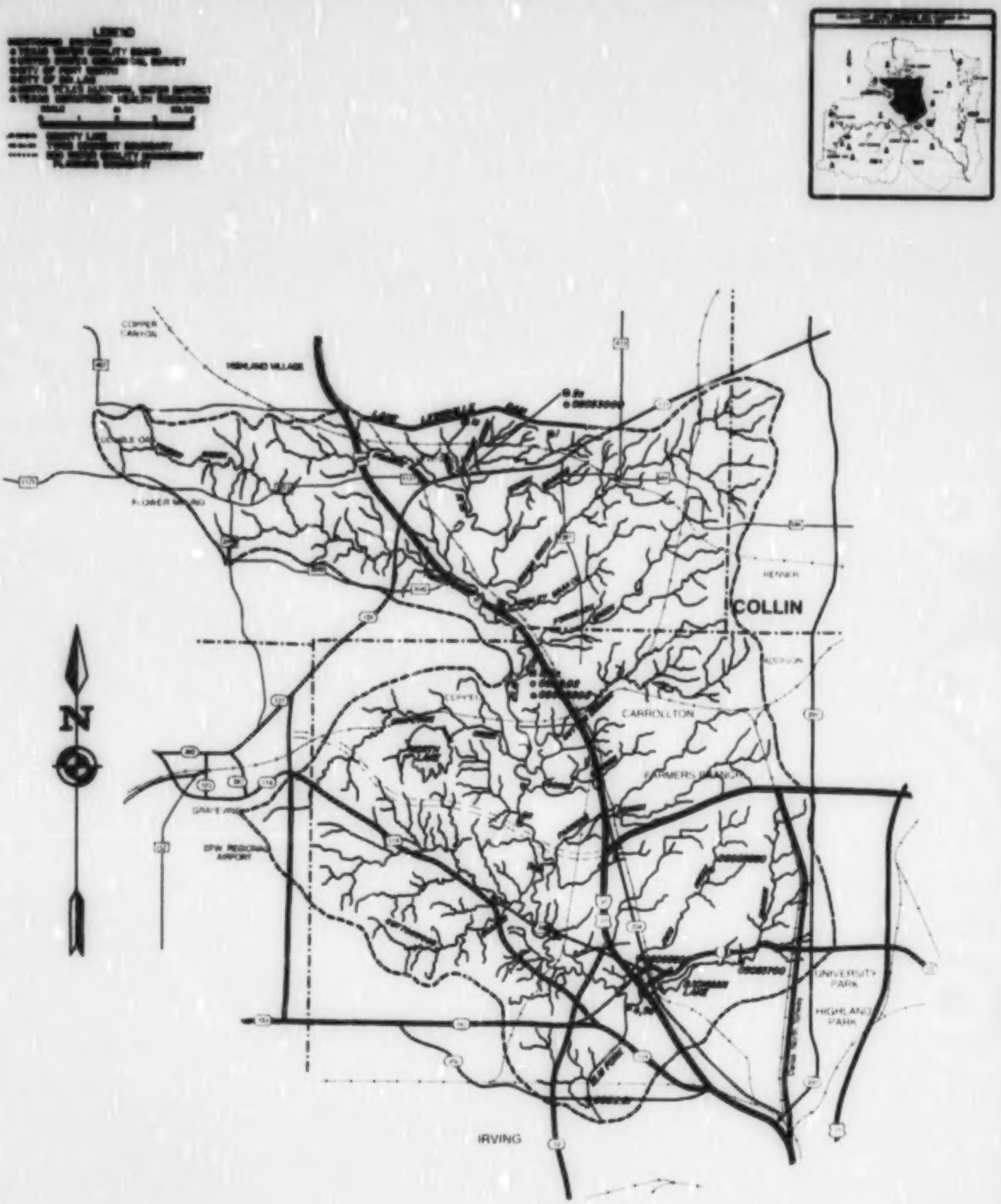
MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Segment 0822			
DAL	Elm Fork Trinity River at Lake Lewisville spillway	1a	B
DAL	Elm Fork Trinity River at SH 121	2a	A
DAL	Elm Fork Trinity River at US 77	3a	A
DAL	Elm Fork Trinity River at Carrollton Dam	5a	B
DAL	Elm Fork Trinity River at Valley View Lane	6a	A
DAL	Elm Fork Trinity River at Royal Lane	7a	A
DAL	Elm Fork Trinity River at California Crossing	8a	A
DAL	Elm Fork Trinity River at Bachman WTP Intake	9a	B
DAL	Elm Fork at Lewisville Spillway	1	A
DAL	Elm Fork at Sandy Lake Road	3	A
DAL	Elm Fork at Frazier Dam	4	A
TWQB	Elm Fork Trinity River at SH 356	0822.01	Cb
TWQB	Elm Fork Trinity River at Carrollton Dam	0822.02	Cb
USGS	Elm Fork Trinity River near Lewisville	08053000	Dd
USGS	Elm Fork Trinity River near Carrollton	08055500	Dd

continued. . .

Agency	Location	Station Number	Type of Record*
USGS	Joes Creek at Dallas	08055600	H
USGS	Bachman Branch at Dallas	08055700	Dd
Segment 0825			
DAL	Denton Creek at Old Denton Road	4a	B
DAL	Denton Creek at SH 121	2	A
TWQB	Denton Creek at SH 121 West of Lewisville	0825.01	Cc
USGS	Denton Creek near Grapevine	08055000	Dd

*The "Type of Record" designations for each Agency are explained under Appendix A: Sources of Information.


LEGEND
COPPER CANYON
HIGHLAND VILLAGE
FLOWER MOUND
COLLIN
ADDISON
COPPELL
CARROLLTON
FARMERS BRANCH
GRAPEVINE
DFW REGIONAL AIRPORT
UNIVERSITY PARK
HIGHLAND PARK
IRVING
N

PRESENTATION AREA C – Segment 0822

TRINITY RIVER AUTHORITY OF TEXAS
Planning and Environmental Management Division

December 1976
FIGURE C1

ELM FORK TRINITY RIVER BETWEEN LEWISVILLE DAM AND CONFLUENCE WITH THE WEST FORK TRINITY RIVER - Segment 0822

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Elm Fork (DAL 1a, 2a, 3a, 5a, 6a, 7a, 8a, 9a, 1, 3, 4; TRA; TWQB 0822.01, 0822.02). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	16.2	27	7.5	6.3	20
Dissolved Oxygen	10.3	12.2	6.2	2.5	20
pH (pH units)	8.1	8.5	7.1	0.3	185
Conductivity (umhos/cm)	330	500	160	92	20
Total Suspended Solids	44	72	12	21	11
Volatile Suspended Solids	15	34	2	**	11
Total Dissolved Solids	160	250	75	50	20
Ammonia, as N	0.29	0.84	0.00	**	51
Nitrate, as N	0.33	0.80	0.05	**	11
Total Phosphate, as P	0.34	2.20	0.05	**	162
Orthophosphate, as P	0.32	1.00	0.02	**	52
Chloride, as Cl	46	60	22	8	188
Sulfate, as SO_4	43	64	25	13	11
Total Alkalinity, as $CaCO_3$	112	154	86	11	176
Total Hardness, as $CaCO_3$	133	180	101	14	176
Chlorophyll a (ug/l)	7	14	2	4	11
Fecal Coliform (#/100 ml)	212*	240000	0	**	184
Total Coliform (#/100 ml)	10400	240000	30	**	175
Fluoride, as F	0.48	0.65	0.20	0.10	176
Iron, as Fe	0.23	0.60	0.10	**	24

*Log. mean to conform to standards.
**Distribution of values clearly non-normal; no standard deviation computed.

In addition to the above parameters, odor measurements are conducted on the Elm Fork by the City of Dallas. Due to the subjectivity of these measurements, they were not included in the WATER ANALYSES table.

Water Quality Standards - These standards for water quality in the Elm Fork Trinity River were taken from TWQB (1976a).

Temperature - Not to exceed 32.2 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable Range: 6.5 - 8.5. Criterion met (several values of 8.5 were reported).
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met.

Chloride - Mean concentration not to exceed 80 mg/l. Criterion met (no reported values exceeded 80 mg/l).

Sulfate - Mean concentration not to exceed 60 mg/l. Criterion met.

Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion not met. Twenty-six reported values were in excess of 1,000, four were in excess of 10,000, and one value was in excess of 100,000 organisms/100 ml. Even with the exclusion of the highest reported value (240,000 organisms/100 ml), the log. mean would be 204 organisms/100 ml. This is still in excess of the standard of 200 organisms/100 ml. TWQB (1976a) specifically states that the standard shall be applied to "representative sampling of not less than 5 samples collected over not more than 30 days." The data reported by the City of Dallas and the TWQB constitute approximately monthly sampling. In addition, data from TRA (37 samples collected over an 8-day period) produced a log. mean of just 161 organisms/ 100 ml. Therefore, a technical violation has not occurred, but a definite problem is indicated.

Figure C2 depicts trends in water quality for the Elm Fork Trinity River. Concentrations of fecal coliform, total phosphate, and turbidity are plotted against river mile for the Elm Fork from the Lewisville outlet to the confluence with the West Fork Trinity River. The parameters fecal coliform and total phosphate show the effect of the Lewisville STP, with a general recovery occurring below IH 35. Turbidity shows a general increasing trend as water passes downstream. Data on other parameters failed to show an increasing or decreasing trend, with water quality remaining generally good for the entire reach.

Tributary Water Analyses - Tributaries entering the Elm Fork Trinity River and actually comprising part of Segment 0822 include Bachman Branch, Joes Creek, Farmers Branch, Cooks Branch, Hutton Branch, Furneaux Creek, Dudley Branch, Indian Creek, Midway Branch, Stewart Creek, Prairie Creek, Timber Creek, Grapevine Creek, and Cottonwood Branch. Denton Creek empties into the Elm Fork, but is a segment of its own and is covered in the section on Presentation Area C, Elm Fork below Lakes. No other water quality data were available for tributaries draining into the Elm Fork, with the exception of Bachman Branch. Both Bachman Branch and Bachman Lake fall within Segment 0822, but warrant consideration separate from that given to the Elm Fork Trinity River.

The Bachman Branch drainage area is equal to 25.9 square kilometers (10.0 square miles). The USGS gaging station on Bachman Branch (USGS 08055700) produces a digital discharge record. The station is located 2.4 kilometers (1.5 miles) upstream from Bachman Lake Dam.

North Lake is located on South Fork which empties into Grapevine Creek, which in turn empties into the Elm Fork. Data on this lake should be analyzed separately, since they would be dissimilar to data on the Elm Fork. North Lake was constructed in 1956 and 1957 and is owned by Dallas Power and Light Company (DP&L). DP&L operates three (3) power generation units with a combined capacity of 700,000 kw. Power generation began in 1959, after the lake first reached normal capacity in May 1957.

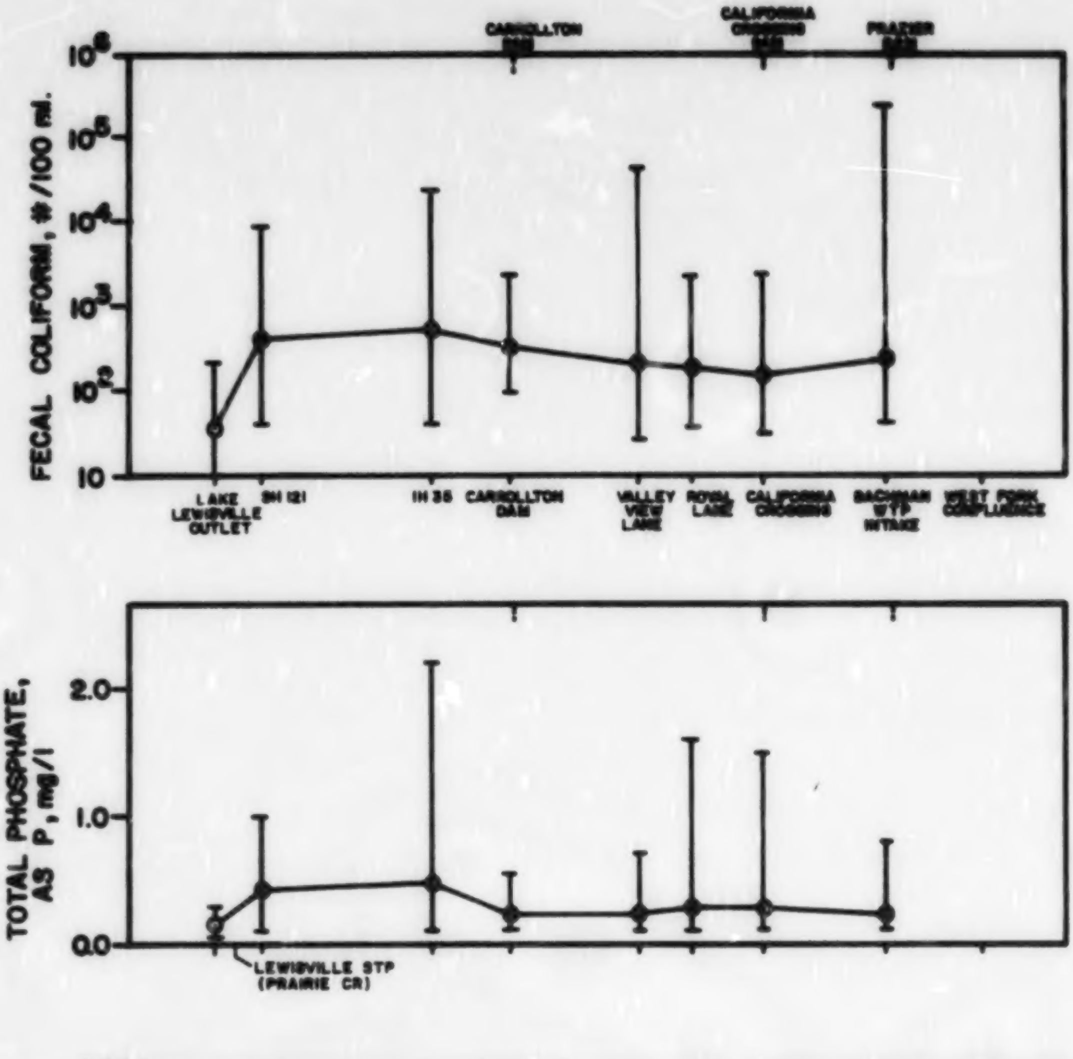


FIGURE C2. ELM FORK (Segment 0822) PROFILES FOR FECAL COLIFORM, TOTAL PHOSPHATE, AND TURBIDITY. VALUES PLOTTED ARE MEANS AND RANGES, AND THE PERIOD COVERED IS FROM 10-1-74 THROUGH 6-30-76.
(DATA FROM CITY OF DALLAS 1956-1976)

North Lake has a drainage area of 7.8 square kilometers (3 square miles). This relatively small drainage area is supplemented by pumping additional needed water from the Elm Fork. The mean depth of North Lake is 6.5 meters (21.3 feet).

The following table summarizes recent water quality data (TPWD, 1976c) on North Lake. The following table was compiled utilizing data collected in May, July, and September of 1975. All concentrations are in mg/l, unless otherwise specified.

North Lake Water Quality, 1975 (Segment 0822)

(Taken from TPWD 1976c)

Parameter	Mean	Max	Min	S	N
Temperature (C)	28.2	32.8	23.9	2.2	6
Dissolved Oxygen	7.7	8.4	7.0	0.5	6
Total Alkalinity, as $CaCO_3$	102	110	90	8	6
Total Hardness, as $CaCO_3$	223	230	220	5	6
pH (pH units)	8.3	8.6	7.9	0.2	6
Secchi (cm)	122	188	91	43	6
Chloride, as Cl	119	119	119	-	2
Conductivity (umhos/cm)	1320	1320	1320	-	2
Total Dissolved Solids	550	568	532	-	2
Total Phosphorus, as P	0.2	0.2	0.2	-	2
Nitrate, as N	0.3	0.3	0.3	-	2

-No standard deviation computed when N is less than six.

Water quality data are not abundant enough to draw conclusions. The water in North Lake would be expected to have relatively higher water temperatures than similar lakes without electric generating facilities, however. Also, the water appears to be relatively hard, with a mean total hardness in excess of 200 mg/l.

The following table summarizes a recent survey conducted by the TPWD on macrophytes in North Lake. No problems appear to exist, although no historical data were available for trend analysis.

North Lake Vegetative Survey, 1975 (Segment 0822)

(Taken from TPWD 1976c)

Common Name	Scientific Name	Extent of Infestation* L	M	H	S
Narrowleaf cattail	Typha angustiofolia	X			
Bulrush	Scirpus validus	X			
Squarestem spikerush	Eleocharis quadrangulata	X			
Softrush	Juncus effusus	X			
Floating pondweed	Potomogeton americanus		X		
Bushy pondweed	Najas guadalupensis	X			

continued. . .

Common Name	Scientific Name	Extent of Infestation* L	M	H	S
Muskgrass	*Chara vulgaris*	X			
Filamentous algae	Chlorophyceae	X			

*L - light vegetation cover; creating no observed problems
M - moderate vegetation; creating a small nuisance to boats and bank fisherman
H - heavy infestation; only boat lanes and small areas are clear; the vegetation severely hampers fishermen and boat traffic
S - severe infestation; the entire area is completely choked with vegetation; no fishing or boating is possible

Table XVII summarizes the fish community in North Lake for the year 1975. Gill net sampling seemed to indicate a predominance of rough fish in the lake: rough fish to game fish ratios were 5 to 1 (biomass) and 4.2 to 1 (number). McNeely (1972) studied the size and food habits of fishes in North Lake.

Sediment Analyses - No data regarding concentrations of contaminants in sediment were encountered for the Elm Fork Trinity River.

Biological
(10-1-74 through 6-30-76)

Bacteria - Results of recent bacteria analyses were presented in the WATER ANALYSES section and in Figure C2. The trend in fecal coliform can best be characterized by the following graph.

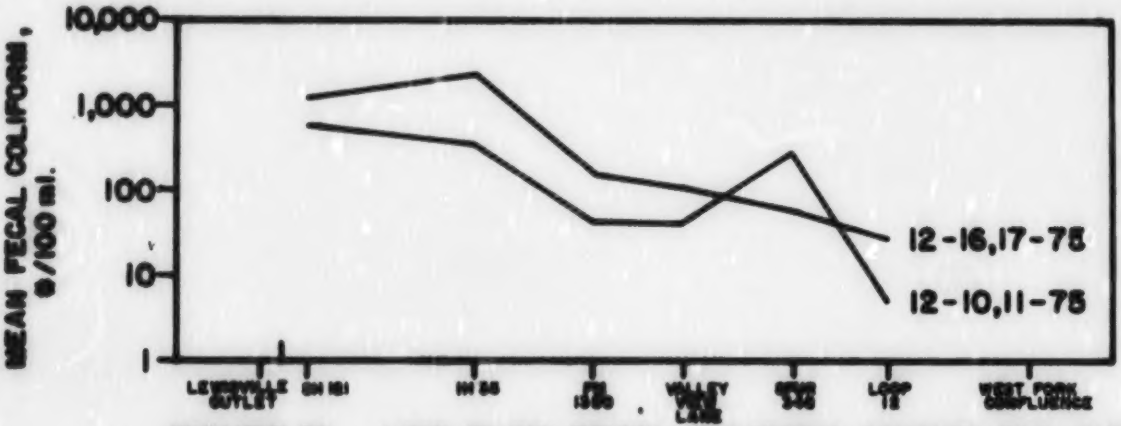


FIGURE C3. LOW FLOW FECAL COLIFORM COUNTS FOR THE ELM FORK TRINITY RIVER (Segment 0822).
(DATA FROM TRA 1976)

TABLE NO. XVII

COMPOSITE RESULTS OF 1975 MONTHLY FISH SAMPLING OF NORTH LAKE (SEGMENT 0822)

(Taken from TPWD 1976c)

	TYPE OF NET*				
	Gill		Seine	Frame	
Species	Average Biomass Kg	Average Number Per Net	Average Number Per 1000 Sq. Ft.	Average Biomass Kg	Average Number Per Net
GAME FISH					
White bass	-	0.20	-	0.13	3.00
Redear sunfish	-	0.20	0.63	0.07	9.40
Bluegill	0.05	0.40	0.75	0.07	8.80
Longear sunfish	-	-	0.13	0.05	0.60
White crappie	0.45	0.40	0.01	-	0.20
Spotted bass	-	-	0.03	-	-
Largemouth bass	0.21	1.00	0.54	-	-
Green sunfish	-	-	0.09	-	-
Channel catfish	0.29	0.80	-	-	-
ROUGH FISH					
River carpsucker	0.93	2.00	-	0.74	0.60
Gizzard shad	0.24	1.20	0.14	-	-
Spotted gar	0.60	0.80	-	-	-
Longnose gar	1.11	2.00	-	-	-
Smallmouth buffalo	1.86	6.20	-	-	-
Freshwater drum	0.29	0.40	-	-	-
FORAGE FISH					
Threadfin shad	-	-	0.24	-	-
Pugnose minnow	-	-	0.02	-	-
Blacktail shiner	-	-	1.23	-	-
Red shiner	-	-	0.10	-	-
Bullhead minnow	-	-	0.29	-	-
Tadpole madtom	-	-	0.03	-	-
Blackstrip topminnow	-	-	0.05	-	-
Mosquitofish	-	-	0.22	-	-
Mississippi silverside	-	-	1.47	-	-
Logperch	-	-	0.16	-	-
TOTALS	6.03	15.50	6.13	1.06	22.60

*Gill Nets - Standard 150' x 8' with mesh ranging from 1"-3½" (set overnight)
Seine - 30' bag seine with ¼" mesh
Frame Nets - 1" mesh (set overnight)

The effect of, as well as the recovery from, the Lewisville STP is clearly shown in Figure C3. Values plotted in this case are arithmetic means, due to the small sample size.

Plankton - The City of Dallas presently conducts regular (monthly) phytoplankton enumerations and generic identification for samples from the Elm Fork. The high reported value for the recent period (10-1-74 through 6-30-76) was 8926 cells/ml, collected at the Lewisville outlet on 9-9-75. The low reported value for the recent period was 0 cells/ml, collected at Bachman WTP intake on 10-2-74. The lowest non-zero value reported was 368 cells/ml, collected at the Bachman WTP intake on 3-3-75.

Aquatic Vegetation - No aquatic vegetation surveys were encountered for the Elm Fork Trinity River.

Macroinvertebrates - TRA (1976a) noted a large, as well as diverse, bivalve community inhabiting the area immediately downstream from California Crossing Dam on the Elm Fork. The most prevalent organism encountered was the Asiatic clam (Corbicula sp.). Other bivalves inhabiting the area included Obliquaria reflexa Raf., Amblema rariplicata (Lam.), Lampsilis sp., and Quadrula sp. No other recent macroinvertebrate data were encountered.

Fishes - No recent data on fish populations in the Elm Fork were encountered.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Figures C4 and C5 show water quality trends in the Elm Fork for the parameters total alkalinity, total hardness, total coliform, and chloride for the period 1956-1976. Other parameters showed a high degree of consistency over this time period and were not graphed. It can be seen from Figures C4 and C5 that the years 1956 and 1957 had unusually high concentrations of total hardness and chloride. This was due to the diversion of Red River water for water supply during that drought period.

Analysis of total coliform data produces what may be an increasing trend (Figure C5). Due to the large number of sources of total coliform organisms, this trend, even if it exists, may be unimportant. Sufficient data for a similar analysis of fecal coliform were not available.

Tributary Water Analyses - The only historical water quality data on tributaries entering the Elm Fork were for Bachman Branch. The maximum flow for the period of record was 453 cubic meters per second (16,000 cfs), recorded on April 28, 1966.

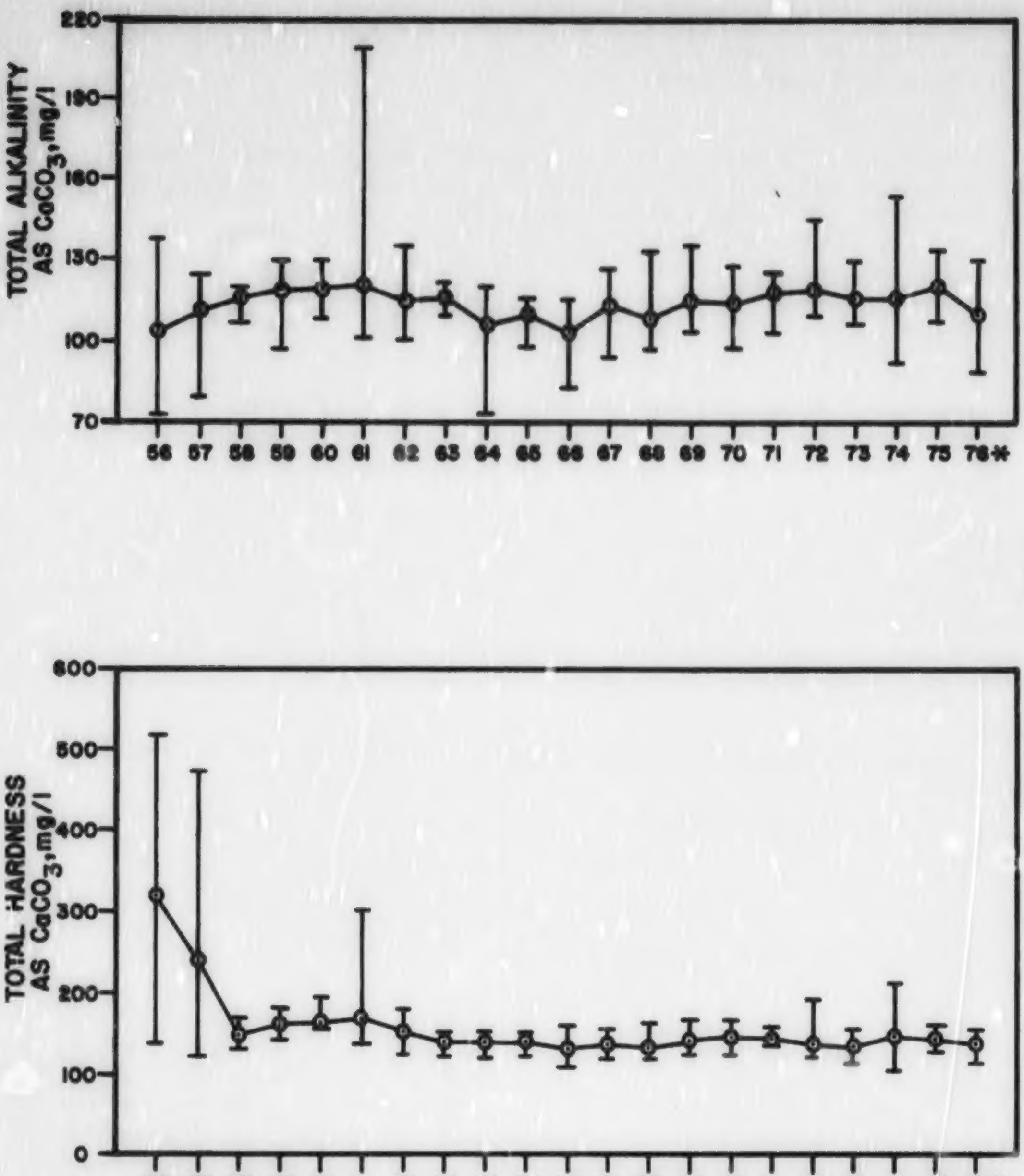


FIGURE C4. HISTORICAL DATA TRENDS EXHIBITED BY TOTAL ALKALINITY, AND TOTAL HARDNESS AT BACHMAN WTP INTAKE (Segment 0822)

DATA PLOTTED ARE MEAN VALUES AND RANGES
(DATA FROM CITY OF DALLAS 1956-1976)
*FOR SIX MONTHS

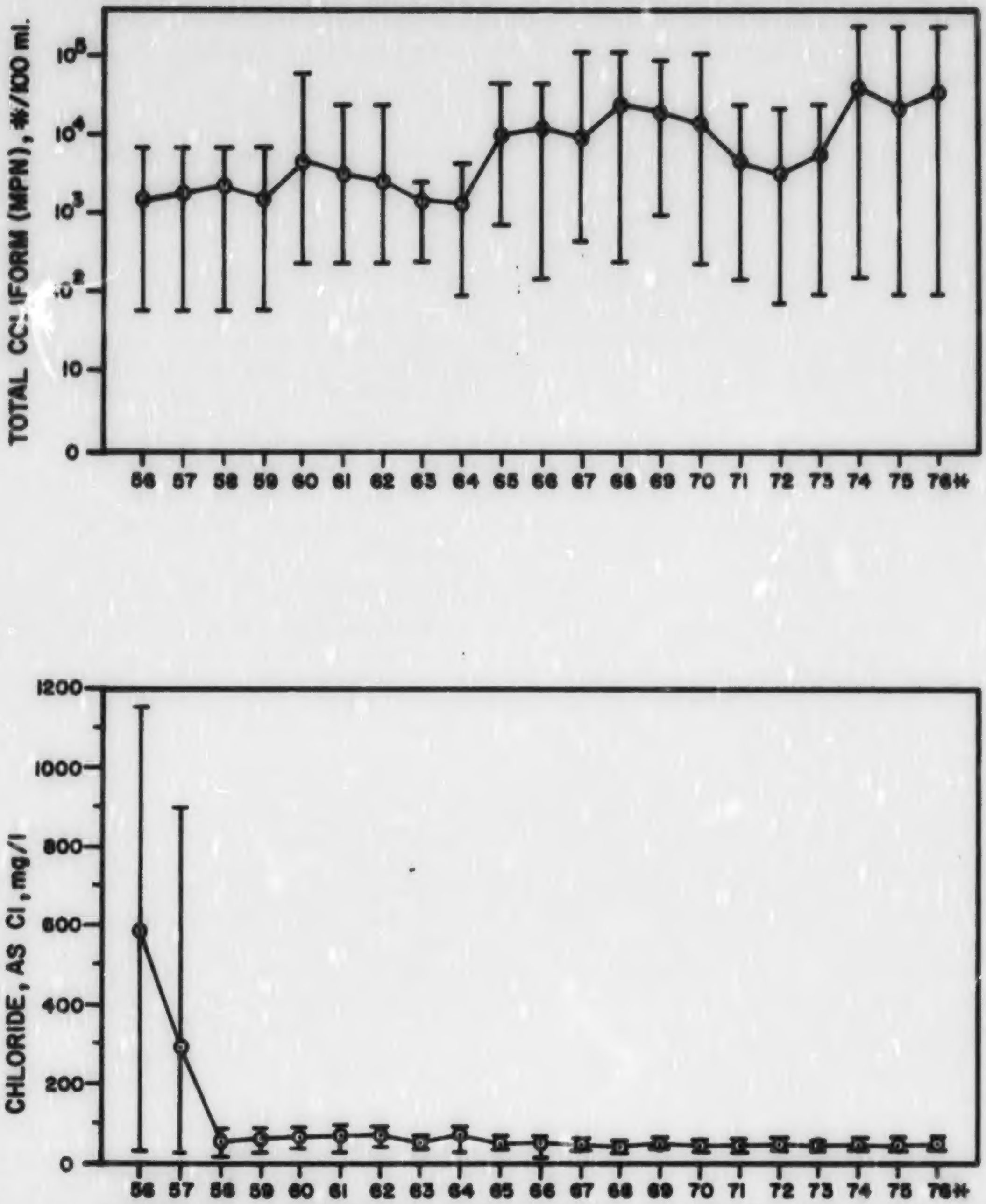


FIGURE C5. HISTORICAL DATA TRENDS EXHIBITED BY TOTAL COLIFORM, AND CHLORIDE AT BACHMAN WTP INTAKE (Segment 0822)

(DATA FROM CITY OF DALLAS 1956-1976)

* FOR SIX MONTHS

DATA PLOTTED ARE MEAN VALUES AND RANGES

Moore (1950), surveying the mayflies of Dallas County, collected Stenonema tripunctatum Bank (listed as "very common") and Choroterpes sp. from a station located one-half mile upstream from Bachman Lake.

No other biological data were encountered for either Bachman Branch or Bachman Lake.

Sediment Analyses - No historical sediment data were encountered for the Elm Fork.

Biological
(Prior to 10-1-74)

Bacteria - Historical total coliform data for Bachman WTP intake are presented in Figure C5. As was stated before, an increasing trend appears to exist. The mean total coliform concentration for the period 1956-1964 was about 2200 organisms/100 ml, while the mean concentration for the period 1974-1976 was about 33,000 organisms/100 ml. Total coliform organisms originate from soil, plants, insects, and old sewage, and specifically are no cause for concern. Inadequate data for fecal coliform organisms (indicative of recent sewage pollution) exist for an analysis similar to that of total coliform data.

Plankton - Historical phytoplankton trends are presented for Lake Lewisville water outlet (Figures C6 and C7) and the Bachman WTP (Figures C8 and C9) for the time period 1967-1976. Both stations show much higher phytoplankton concentrations since 1971. The highest concentration reported was 8926 cells/ml at Lake Lewisville outlet on 9-9-75. The lowest concentration reported was 0 organisms/ml at Bachman WTP intake on 10-2-74.

Samples generally contained a predominance of diatoms, with green algae constituting a large portion of the remainder. An obvious diatom "bloom" occurred at the Bachman WTP intake on 5-17-71, with 99% of the phytoplankton counted being diatoms (3508 diatoms out of 3540 phytoplankters/ml). A green algal bloom occurred on 3-23-76 at the Lake Lewisville outlet, with 71% of the algae enumerated being green (2016 green algae out of 2848 phytoplankters/ml). A blue-green algal bloom took place at the Lake Lewisville outlet on 9-9-75, with 63% of the algae being blue-green (5646 blue-green algae out of 8926 total algae/ml). Of the blue-green algae encountered in this bloom, 89% were of the genus Oscillatoria.

Aquatic Vegetation - No historical data were encountered which dealt with aquatic macrophytes in the Elm Fork Trinity River.

Macroinvertebrates - Moore (1950) reported excellent macroinvertebrate collecting conditions below Carrollton Dam on the Elm Fork. The following table summarizes the organisms collected in that study.

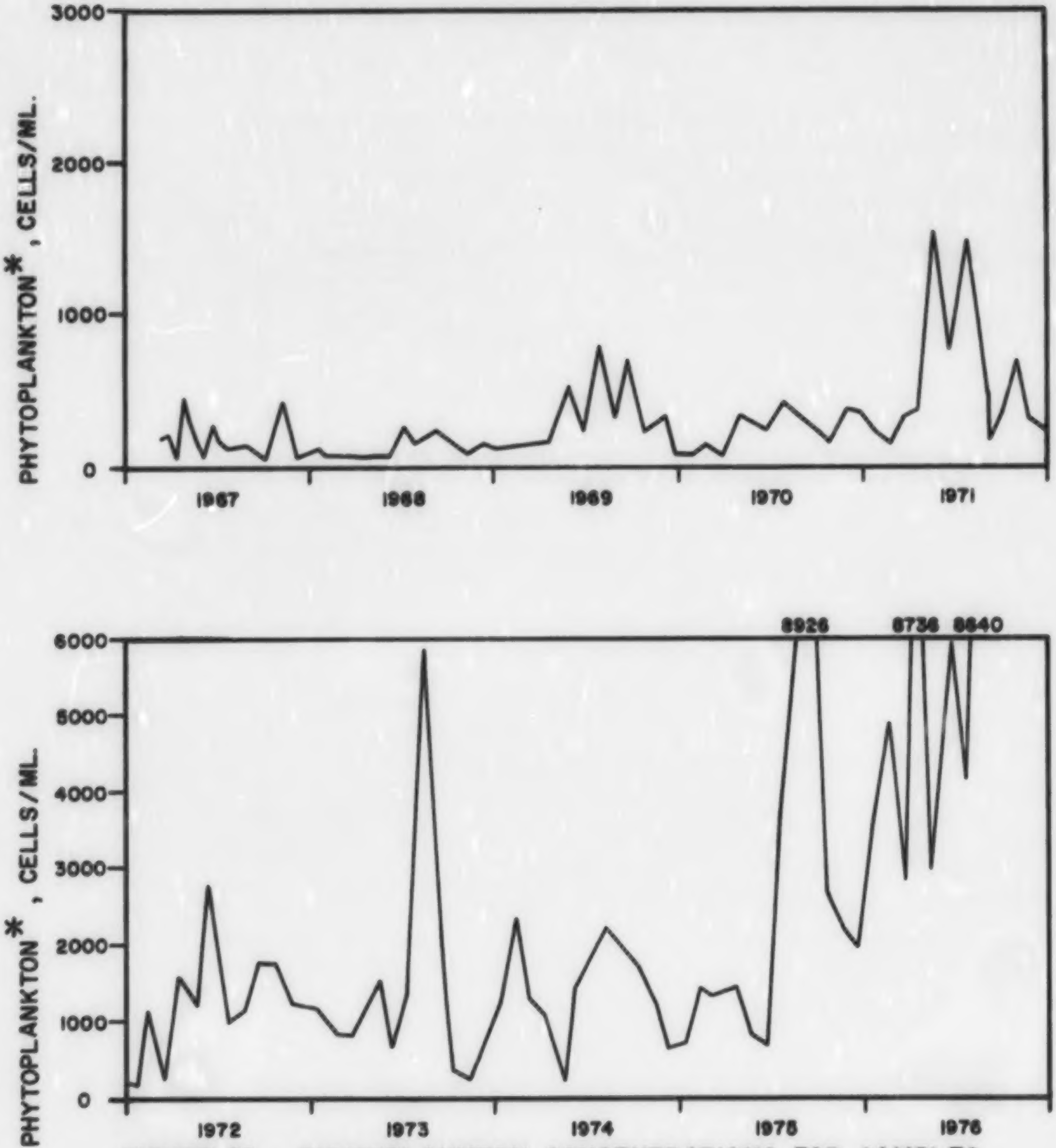


FIGURE C6. PHYTOPLANKTON CONCENTRATIONS FOR SAMPLES FROM LAKE LEWISVILLE WATER OUTLET (Segment 0822)
(DATA FROM CITY OF DALLAS 1967-1976 c)
* NOTE SCALE CHANGE

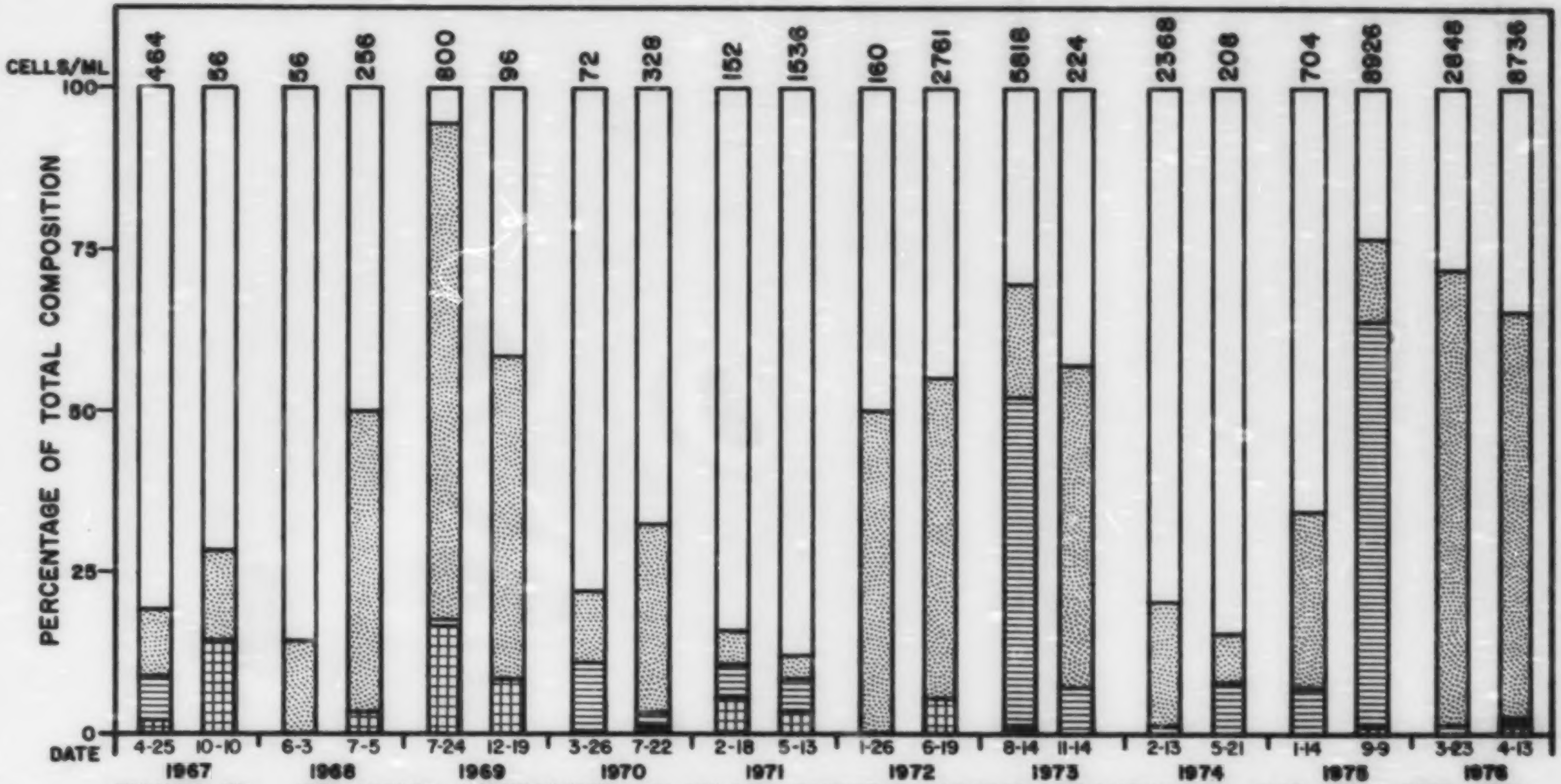


FIGURE C7. RELATIVE ABUNDANCE OF MAJOR PHYTOPLANKTON GROUPS FOR THE HIGH AND LOW CONCENTRATIONS OF EACH YEAR AT LAKE LEWISVILLE OUTLET TOWER (Segment 0822)

☐ =DIATOMS ▒ =GREEN ALGAE

▤ =BLUE-GREEN ALGAE ▦ =FLAGELLATES

(DATA FROM CITY OF DALLAS 1967-1976 c)

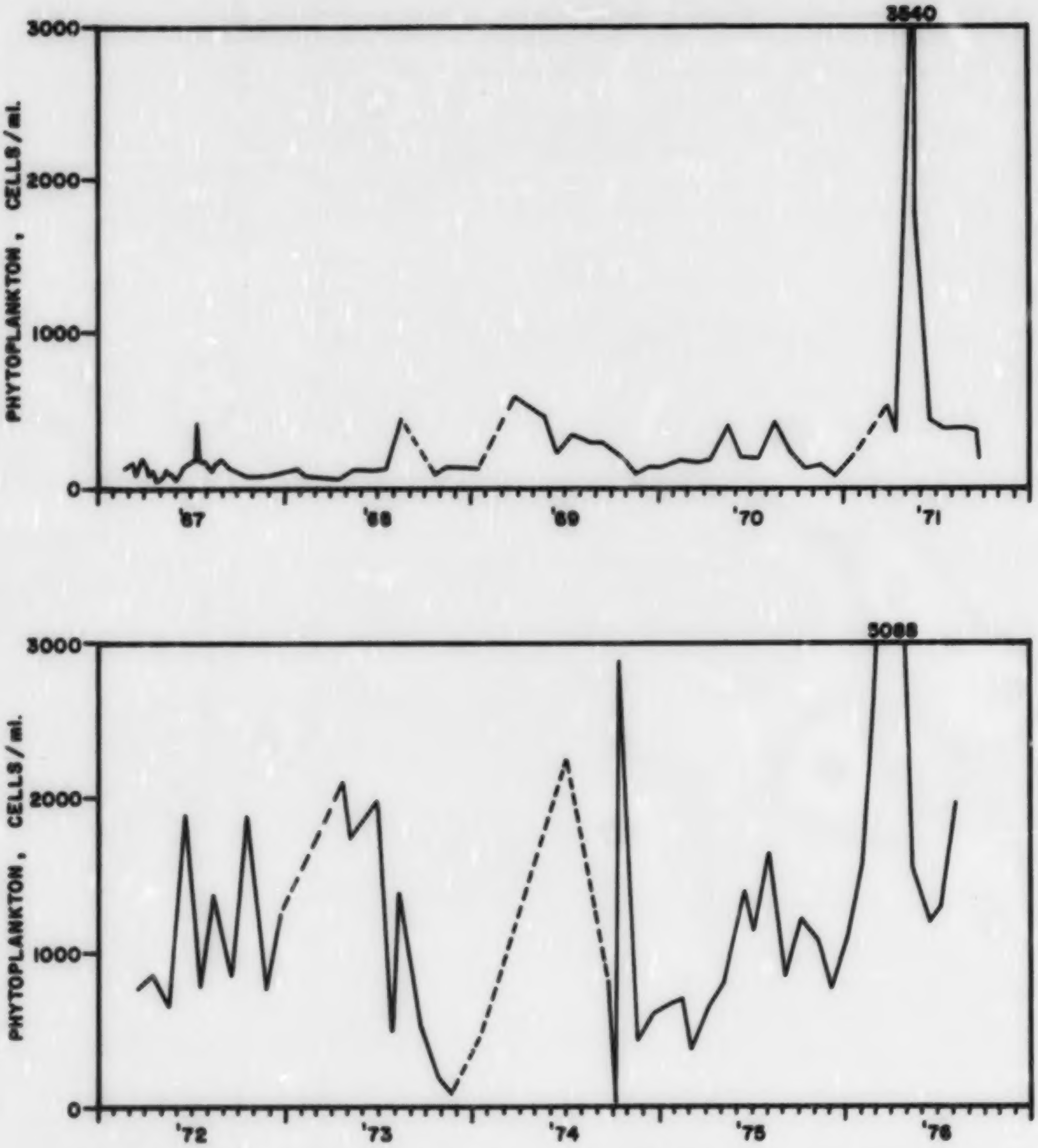


FIGURE C8. PHYTOPLANKTON CONCENTRATIONS FOR SAMPLES
FROM BACHMAN WTP INTAKE (Segment 0822)
(DATA FROM CITY OF DALLAS 1967-1976 a)

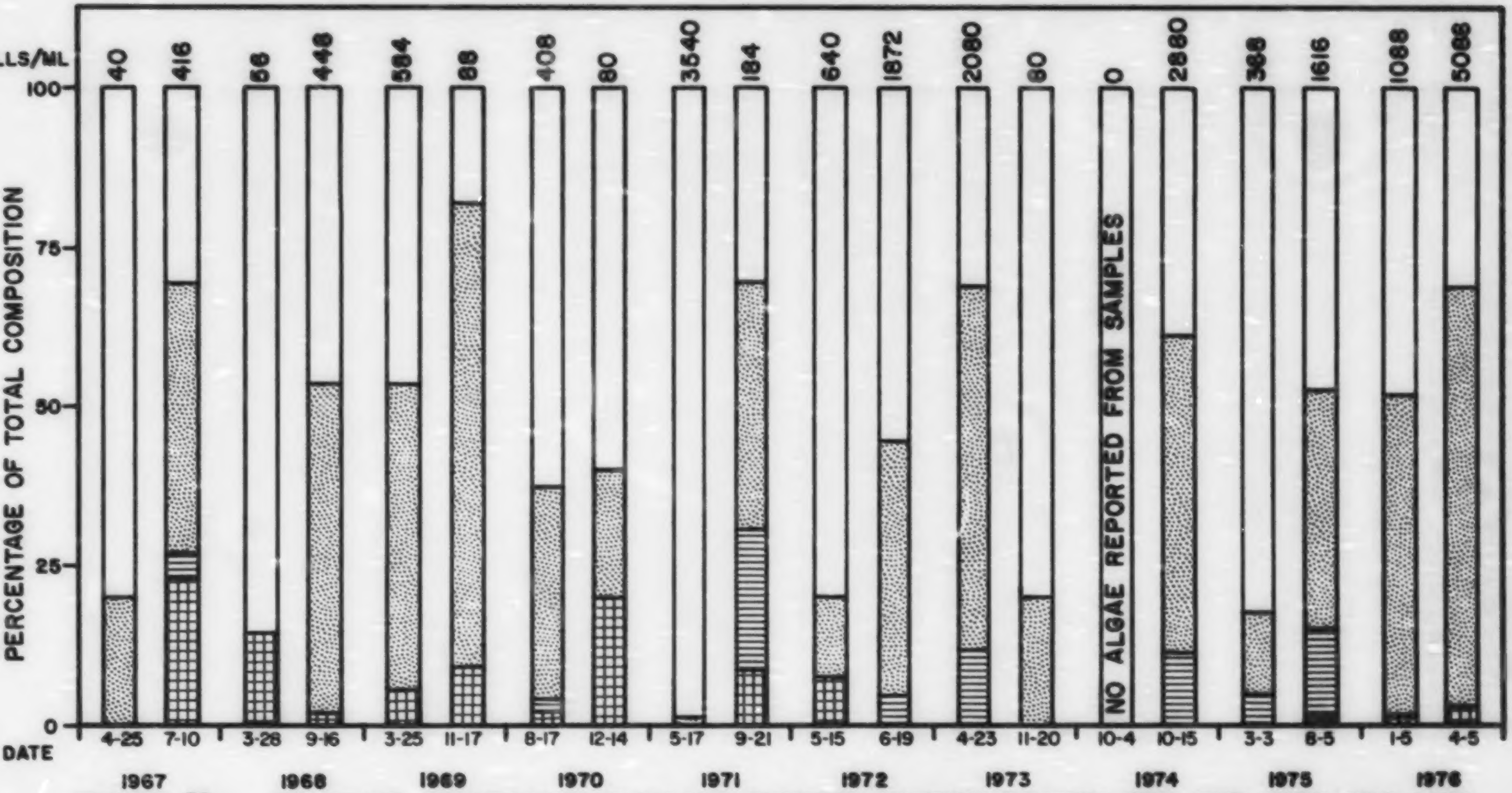


FIGURE C9. RELATIVE ABUNDANCE OF MAJOR PHYTOPLANKTON GROUPS FOR THE HIGH AND LOW CONCENTRATIONS OF EACH YEAR AT BACHMAN WTP INTAKE (Segment 0822)

☐ =DIATOMS
▒ =GREEN ALGAE
▤ =BLUE-GREEN ALGAE
▦ =FLAGELLATES

(DATA FROM CITY OF DALLAS 1967-1976 a)

Ephemeroptera of the Elm Fork

(Taken from Moore 1950)

Organism	Comments
Family Heptageniidae	
Stenonema candidum Traver.	Abundant
S. majus Traver.	Not Abundant
S. pulchellum Walsh.	Abundant
S. terminatum Walsh.	Not Abundant
Family Baetidae	
Choroterpes sp.	
Isonychia (aurea) Traver.	
Baetis cingulatus McDonnough	
B. parvus-brunneicolor group	
Centroptilum album McDonnough	

Moore (1950) states that this station underwent "three major floods" during the fall and winter of the study period, but that no effects on the benthic organisms were detectable.

Hellier (1972) discovered large populations of the bivalves *Quadrillo* sp. and *Truncilla* sp. in shallows upstream from IH 35. No other historical data on benthic macroinvertebrates were encountered.

Fishes - Hellier (1972) conducted a fish survey of the Elm Fork Trinity River. However, high flows prevented quantification of the fish present. Table XVIII presents the results of this fish survey. The fish present contain a good number of game fish, reflecting the generally good water quality of the Elm Fork.

Fullwood (1950) surveyed copepoda parasitic to fishes at two stations in the Elm Fork (Table No. XIX). Only one parasite, *Ergasilus versicolor*, was encountered during the study. This parasite was found attached to the gill filament of a white crappie, *Pomoxis annularis*.

NONPOINT VS. POINT SOURCE LOADINGS

Segment 0822 is approximately 30 miles in length, comprised of the Elm Fork Trinity River from Lewisville Dam to its confluence with the West Fork Trinity River. This segment includes three channel dams and two withdrawal points diverting water for municipal water supplies.

Denton Creek is the major tributary in this segment of the Elm Fork. Discharges from Lake Lewisville are joined by releases from Grapevine Lake at the confluence of Denton Creek and the Elm Fork at a point 0.5 kilometers (0.3 mile) upstream from Carrollton Dam, where there is a USGS gaging station (USGS 08055500). Normal releases from the two reservoirs essentially provide raw water for Dallas water treatment plants. Very little water makes it to the West Fork, particularly during the summer low flow period. The flow frequency curve at the USGS Carrollton station

TABLE NO. XVIII

FISHES COLLECTED IN THE ELM FORK (SEGMENT 0822) DURING AUGUST AND SEPTEMBER OF 1971

(Taken from Hellier 1972)

Scientific Name	Common Name
Lepisosteus osseus (Linnaeus)	long-nosed gar
Dorosoma petenense (Gunther)	threadfin shad
Dorosoma cepedianum (LeSueur)	gizzard shad
Notemigonus crysoleucas (Mitchell)	golden shiner
Notropis venustus (Girard)	blacktail shiner
Notropis lutrensis (Baird and Girard)	red shiner
Notropis atrocaudalis Everman	blackspot shiner
Pimephales vigilax (Baird and Girard)	bullhead minnow
Ictalurus punctatus (Rafinesque)	channel catfish
Ictalurus melas (Rafinesque)	black bullhead
Noturus nocturnus (Jordan and Gilbert)	freckled madtom
Fundulus notatus (Rafinesque)	blackstripe topminnow
Gambusia affinis (Baird and Girard)	mosquitofish
Menidia audens Hay	Mississippi silverside
Roccus chrysops (Rafinesque)	white bass
Micropterus punctulatus (Rafinesque)	spotted bass
Micropterus salmoides(Lacepede)	largemouth bass
Chaenobryttus gulosus (Cuvier)	warmouth
Lepomis macrochirus Rafinesque	bluegill
Lepomis megalotis (Rafinesque)	longear sunfish
Pomoxis annularis Rafinesque	white crappie
Percina sciersus Swain	dusky darter
Percina caprodes (Rafinesque)	logperch
Etheostoma spectabile (Agassiz)	orange throat darter
Aplodinotus grunniens Rafinesque	freshwater drum

TABLE NO. XIX

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR ELM FORK TRINITY RIVER (SEGMENT 0822)

(Taken from Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	4	1"-2"
Notropis lutrensis Plains red shiner	123	1½"-2 3/4"
Ceratichthys vigilax (*Pimephales vigilax* (Baird and Girard)) Bullnose minnow (Bullhead minnow)	45	1"-3"
Opsopoeodus emiliae Pugnose minnow	17	1"-1½"
Campostoma anomalum Stoneroller	20	1½"-3¼"
Gambusia aifinis Mosquitofish	18	1½"-2"
Lepomis macrochirus Bluegill	24	2"-5"
Lepomis megalotis Longear sunfish	24	4"-6"
Labidestes sicculus (*Labidesthes sicculus* (Cope)) Brook silverside	20	2½"-3"
Pomoxis annularis White crappie	9	2½"-6"
Pomoxis nigro-maculatus Black crappie	10	3"-3½"
Huro salmoides (*Micropterus salmoides* (Lacepede)) Black bass (Largemouth bass)	7	5"-8"

TABLE NO. XIX (cont.)

Species	Number Captured	Size Range
Lepibema chrysops (*Morone chrysops* (Rafinesque)) Sand bass (White bass)	16	4"-5"
Dorosoma cepedianum Gizzard shad	40	3"-7"
Aplodinotus grunniens Freshwater sheepshead (Freshwater drum)	10	5"-7½"
Hydropterus scierus (*Percina sciera* (Swain)) Dusky darter	49	2"-4"
Boleosoma chlorosomum (*Etheostoma chlorosomum* (Hay)) Bluntnose darter	18	1¼"-1½"
Megastomatobus cyprinella (*Ictiobus cyprinellus* (Valenciennes)) Big mouth buffalo (Largemouth buffalofish)	10	10"-12"
Cyprinus carpio Carp	12	3"-7"
Ictalurus lacustris (*Ictalurus punctatus* (Rafinesque)) Southern channel catfish	52	2"-8"
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) Black bullhead	20	3"-6½"
Schilbeodes nocturnus (*Nocturus nocturnus* (Jordan and Gilbert)) Freckled madtom	7	1½"-2 3/4"
Total	555	

Note: Only one parasitic copepod, *Ergasilus versicolor* with egg case, was encountered. The parasite was found attached to a gill filament of a *Pomoxis annularis*.

is presented in Figure C10. This figure shows that the Elm Fork flows range from 100 to 300 cfs for more than 50% of the time. It is evident from this figure that the streamflow is highly regulated by the two reservoirs.

In general, water quality in this segment is good. The quality of water is very sensitive to the quality of water released from the two upstream reservoirs. Controlled water quality behind the dams for both reservoirs appears to have a direct impact on the streamflow quality. Algal blooms, particularly in Lake Lewisville, have created odor and taste problems which have to be removed by carbon adsorption at the water treatment plants. Since the 1930's, the Dallas water treatment plants have intermittently applied this process to treat their water.

Due to the expanding of the metroplex area, the watershed in the immediate vicinity of the Elm Fork has experienced dramatic growth in recent years. The principal cities within the watershed are Lewisville, Carrollton, Farmers Branch, Grapevine, and Coppell, along with portions of northwest Dallas and northeast Irving. It is believed that massive suburban development and industrial expansion, including the Dallas-Fort Worth Regional Airport, will change the watershed hydrology and water quality.

According to TWQB (1975-1976), there exist one industrial and two domestic point sources with flows in excess of 0.002 cubic meters per second within the Elm Fork watershed.

WATER USES

Domestic and Municipal

The Elm Fork Trinity River from Lewisville dam to the confluence with the main stem of the Trinity River is very heavily used as a source of domestic and municipal water. The City of Dallas and the Dallas County Park Cities Municipal Utilities District are the primary users. The segment is used to convey water from Grapevine and Lewisville Lakes to diversion points downstream.

Industrial

The Elm Fork Trinity River is moderately used as a source of industrial water. By a contractual agreement with the City of Dallas a total of 1.16×10^7 cubic meters (9,500 acre-feet) of water per year may be pumped from the Elm Fork into North Lake. The sole user of the water at North Lake is Dallas Power and Light Company who uses the water to cool steam condensing towers. In this process an average of 0.14 cubic meters per second (3.2 MGD) are consumed by evaporation.

Agricultural

According to NCTCOG (1974), the water of the Elm Fork is not used as an agricultural water supply.

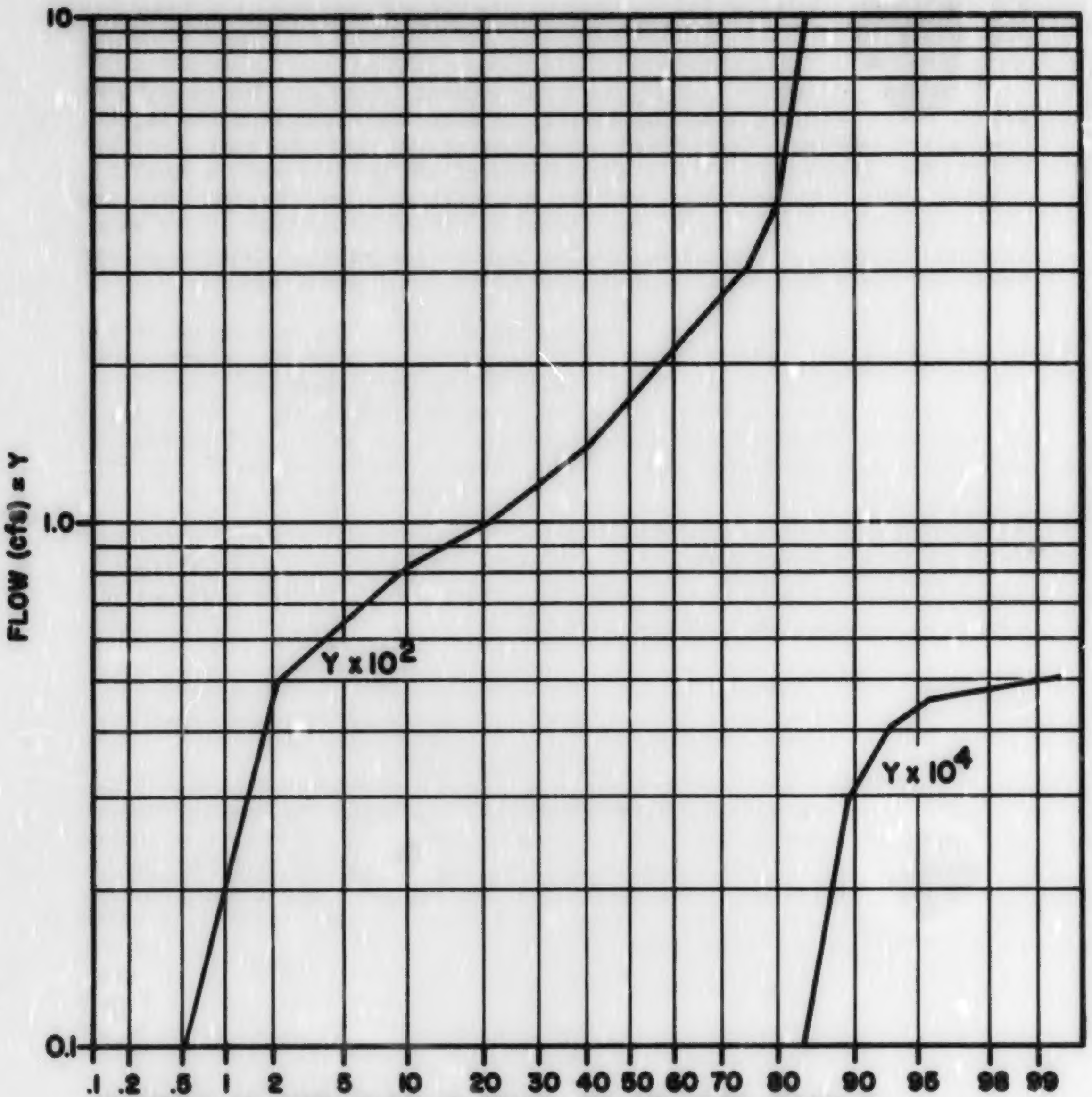


FIGURE C10. FLOW FREQUENCY ANALYSIS FOR THE ELM FORK TRINITY RIVER NEAR CARROLLTON (USGS 08055500). (DATA FROM USGS 1961-1969)

Recreational

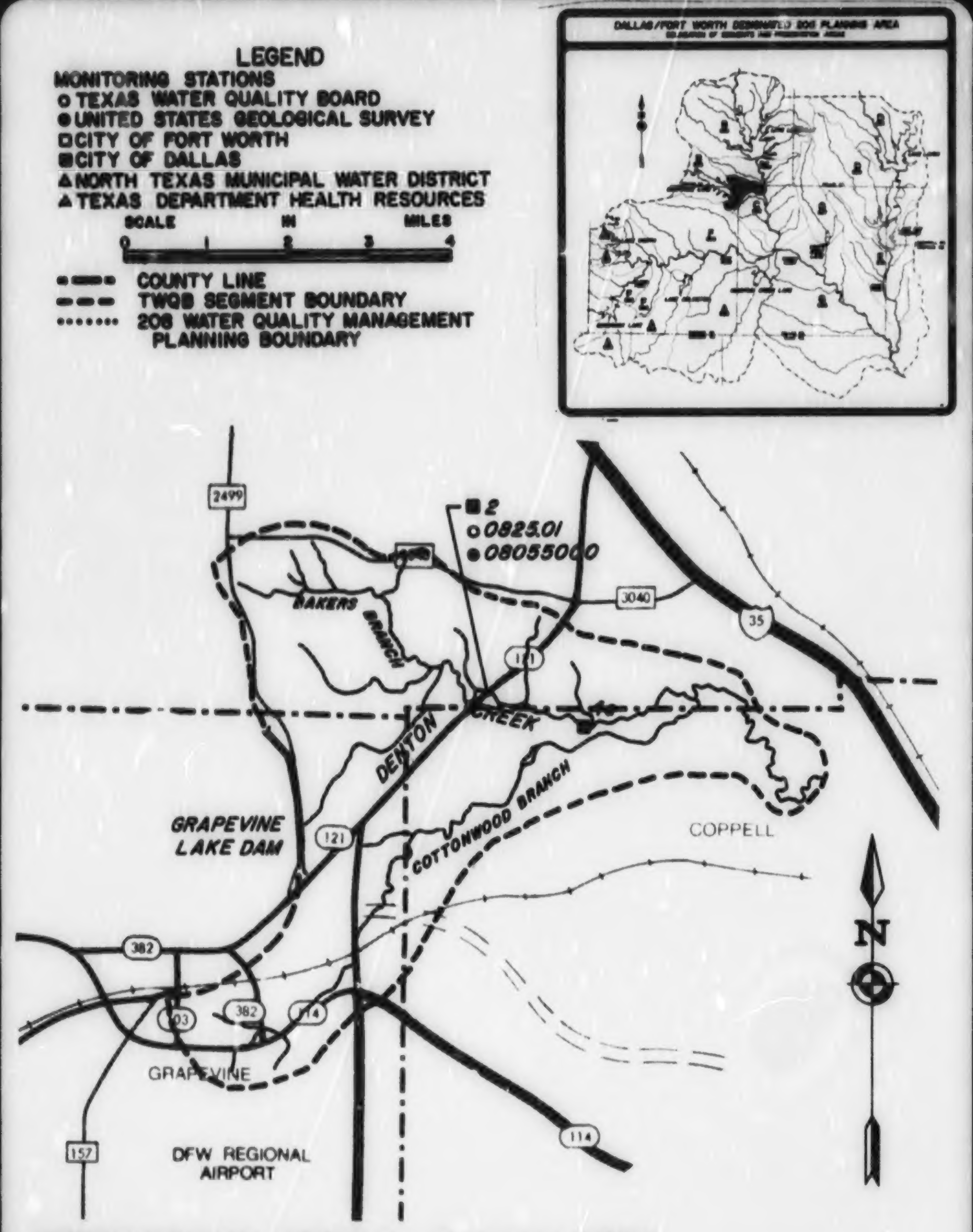
The Elm Fork Trinity River below Lake Lewisville is moderately used as a source of local recreation. Activities occurring in this segment are mainly fishing and canoeing.

SUMMARY

Water quality in the Elm Fork appears to be good with some exceptions. All of the TWQB (1976a) criteria were met, with the possible exception of fecal coliform. The standard was not technically violated, although it appears as though a problem may exist with this parameter. Nutrient concentrations are moderately high and apparently sustain large populations of phytoplankton in the Elm Fork.

Few data were encountered for sediment analyses or tributaries draining into the Elm Fork (Denton Creek covered separately). Biological data revealed high phytoplankton counts, particularly in recent years. This has resulted in a certain amount of taste and odor, making water treatment more difficult.

Historical water analyses reveal basically constant trends in water quality. Some very high chloride, alkalinity, and hardness concentrations resulted in the mid-1950's when water from the Red River was pumped into the Elm Fork.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA
■ 2
○ 0825.01
● 08055000
2499
3040
35
121
BAKERS BRANCH
DENTON CREEK
COTTONWOOD BRANCH
GRAPEVINE LAKE DAM
COPPELL
N
382
303
114
GRAPEVINE
157
DFW REGIONAL AIRPORT

PRESENTATION AREA C - Segment 0825

TRINITY RIVER AUTHORITY OF TEXAS — December 1976
Planning and Environmental Management Division — FIGURE C11

DENTON CREEK BETWEEN GRAPEVINE LAKE AND CONFLUENCE WITH THE ELM FORK TRINITY RIVER - Segment 0825

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Denton Creek (DAL 4a, 2; TWQB 0825.01; TRA). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	15.5	27.0	7.0	5.8	27
Dissolved Oxygen	9.6	12.2	6.9	1.7	27
pH (pH units)	8.0	8.4	7.5	0.2	50
Conductivity (umhos/cm)	360	500	125	73	28
Total Suspended Solids	17	24	10	-	5
Volatile Suspended Solids	4	6	0	-	4
Total Dissolved Solids	167	250	63	58	10
Ammonia, as N	0.13	0.70	0.00	**	8
Nitrate, as N	0.18	0.34	0.03	**	6
Organic Nitrogen, as N	0.8	0.8	0.8	-	2
Total Phosphate, as P	0.05	0.26	0.03	**	29
Orthophosphate, as P	0.03	0.17	0.00	**	25
Chloride, as Cl	21	29	10	5	44
Sulfate, as SO_4	31	40	22	7	6
Total Alkalinity, as $CaCO_3$	125	154	96	15	22
Total Hardness, as $CaCO_3$	146	180	110	18	22
Chlorophyll _a_ (ug/l)	4	6	1	2	8
Fecal Coliform (#/100 ml)	53*	300	0	**	29
Total Coliform (#/100 ml)	2390	24000	90	**	35
Total Organic Carbon	9.5	10	9	-	2
Turbidity (JTU)	21	40	6	**	25
Fluoride, as F	0.32	0.60	0.20	0.12	22

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Denton Creek were taken from TWQB (1976a).

Temperature - Not to exceed 32.2 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable Range: 6.5 - 8.5. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met (no reported values exceeded 500 mg/l).
Chloride - Mean concentration not to exceed 80 mg/l. Criterion met (no reported values in excess of 80 mg/l).

Sulfate - Mean concentration not to exceed 60 mg/l. Criterion met (no reported values exceeded 60 mg/l).
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Tributary Water Analyses - Tributaries flowing into Denton Creek and actually included in Segment 0825 include Bakers Branch, Cottonwood Branch, and four small unnamed tributaries. During extended periods of no rainfall, many or all of these tributaries may dry up completely. There were no water quality data encountered for tributaries draining into Denton Creek.

Sediment Analyses - No data regarding the concentrations of contaminants in sediment were encountered for Denton Creek.

Biological
(10-1-74 through 6-30-76)

Bacteria - Available bacteria data were presented in the WATER ANALYSES section. These included data on fecal and total coliform. The logarithmic mean fecal count was 53 organisms/100 ml, which was well within the established standard for Segment 0825. The maximum fecal count reported was 300 organisms/100 ml, and the maximum total coliform count reported was 24,000 organisms/100 ml.

Plankton - The City of Dallas has conducted phytoplankton counts and generic indentification on phytoplankton samples from Denton Creek at Old Denton Road since 1967. Summarizing the most recent of these data (10-1-74 through 6-30-76), we find that a maximum count of 5568 cells/ml (81% green algae) occurred on 4-13-76. The low concentration for this same period was 610 cells/ml (70% diatoms), which occurred on 11-21-74.

Aquatic Vegetation - No recent data were encountered for Segment 0825 regarding aquatic macrophytes present.

Macroinvertebrates - According to Pettitt (1977), Denton Creek harbors a healthy population of bivalves. Amblema perplicata, Anodota imbicilis, A. grandis, Tritogonia verrucosa, Proptera sp., Lampsilis hydiana, L. anodontoides, and Truncilla truncata are all reported to occur there.

Fishes - No recent data regarding the fish community in Denton Creek were encountered.

HISTORICAL WATER QUALITY AND TRENDS

Water quantity and quality in this segment are influenced by releases from Grapevine Lake, which first achieved normal capacity in 1957.

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Water quality in Denton Creek has remained essentially static over the years, as is exhibited by Figure C12. This figure shows trends for chloride, total hardness, and total coliform. Other paramaters showed a similar consistency of mean concentrations, with generally a lesser degree of variation in range.

Chloride was presented in Figure C12 to illustrate the fact that the mean concentrations for WY 1956 and WY 1957 were not unusually high, as was the case for Segment 0822 (See Figure C6). Hardness values indicate that the water is moderately hard to hard. There is little fluctuation in mean values, but considerable variation in range from year to year.

Average fecal coliform counts showed little change from year to year, but ranges maintained a high degree of variability within any given water year. Data on fecal coliform counts were not plentiful enough to develop a similar trend analysis.

Biological
(Prior to 10-1-74)

Bacteria - Figure C12 presents means and ranges for total coliform counts since 1956. The high count reported for the 19-year period was 1.1×10^5 organisms/100 ml, and the low count reported was 23 organisms/100 ml. There is no noticeable trend exhibited by the mean values, and each year has a high degree of variation in bacteria counts.

Plankton - Hasty (1950) conducted a quantitative and ecological study of the plankton present in Denton Creek. It was found that 97% of the plankton community were phytoplankers. Also, it was found that 95% of the phytoplankters were diatoms. *Navicula* sp. was the most frequently occurring (i.e., in the most samples) diatom, while *Melosira* sp. was the most abundant in terms of total numbers.

Figures C13 and C14 show historical trends (1967-1976) for phytoplankton numbers and composition in Denton Creek. The years 1973, 1974, and 1976 contain particularly high cell counts, while the period 1967 through 1972 shows relatively lower counts (Figure C13). With the exception of the massive diatom bloom in early 1973, the high cell counts of each year since that time have contained a relatively higher proportion of green algae. This appears to be the main difference between the periods 1967-1972 and 1973-1976.

Hasty (1950) reported 3% of the plankton community consisted of zooplankters, particularly rotifers. No other historical zooplankton data were encountered.

Aquatic Vegetation - No aquatic vegetation surveys were encountered for Denton Creek.

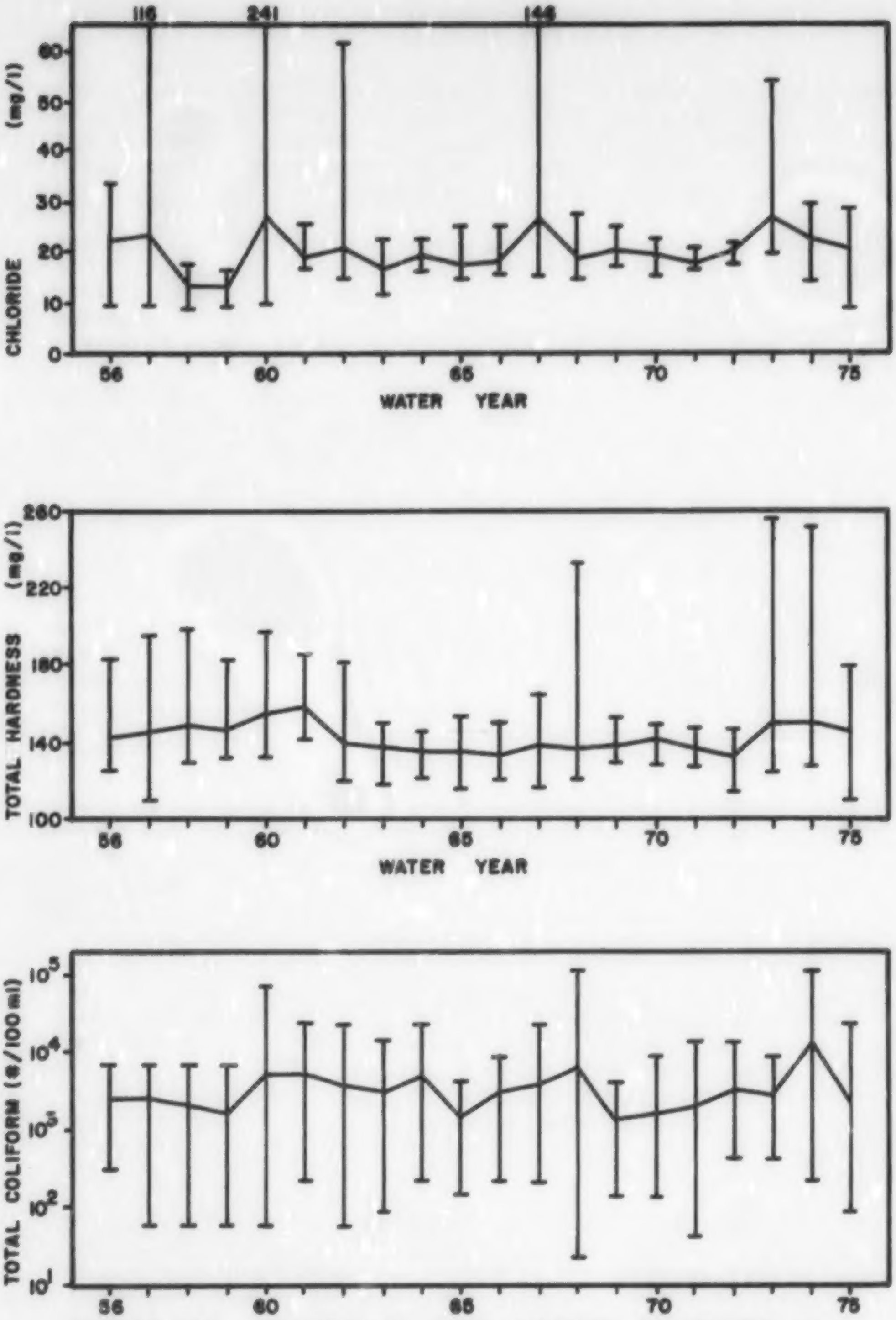


FIGURE C12. HISTORICAL DATA TRENDS EXHIBITED BY CHLORIDE, TOTAL HARDNESS, AND TOTAL COLIFORM FOR DENTON CREEK (Segment 0825)

DATA PLOTTED ARE MEAN VALUES AND RANGES.
(DATA FROM CITY OF DALLAS 1956-1976)

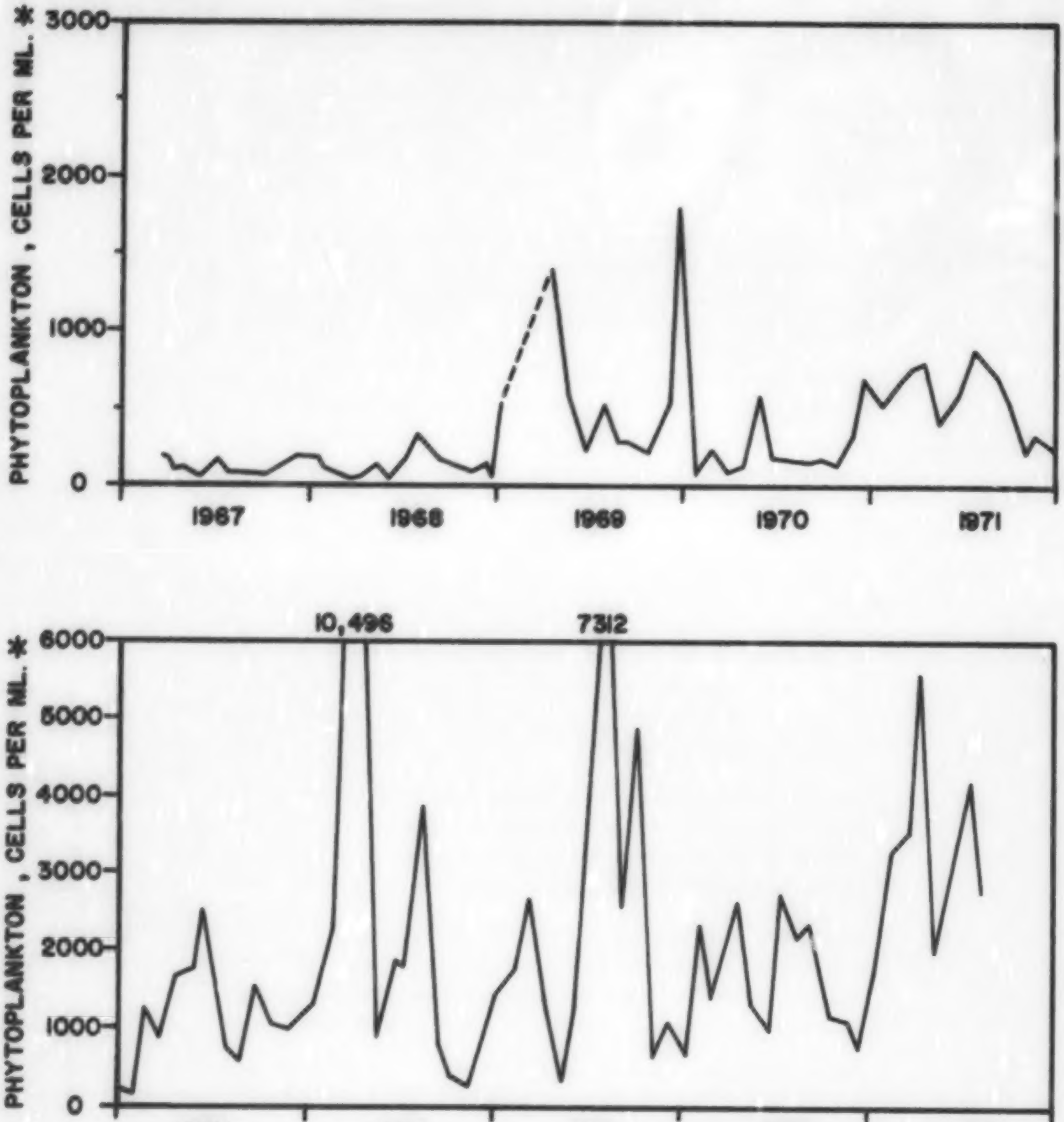


FIGURE C13. TOTAL PHYTOPLANKTON CONCENTRATIONS FOR SAMPLES FROM DENTON CREEK (Segment 0825)
(DATA FROM CITY OF DALLAS 1967-1976 b)
* NOTE SCALE CHANGE

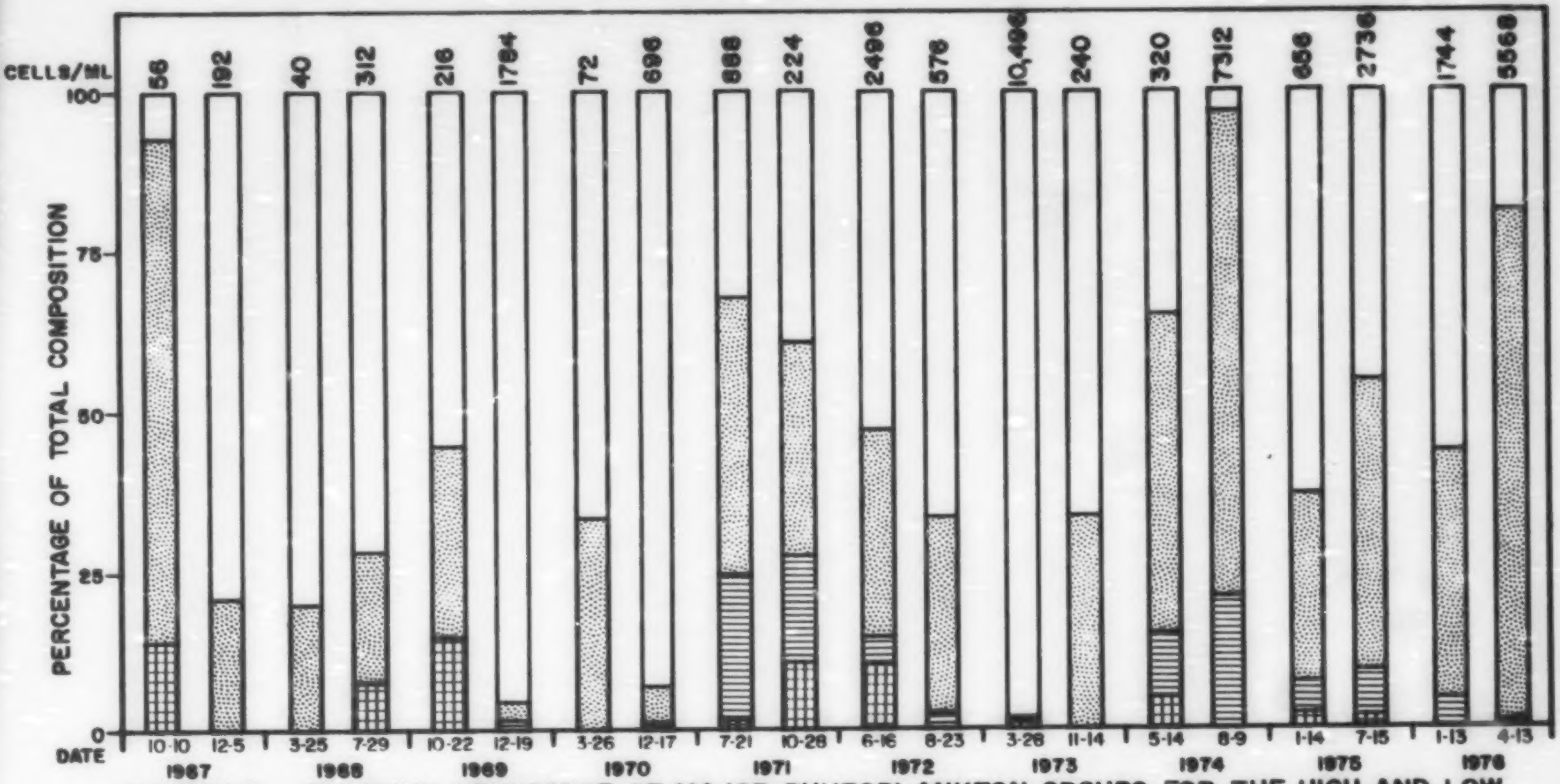


FIGURE C14. RELATIVE ABUNDANCE OF MAJOR PHYTOPLANKTON GROUPS FOR THE HIGH AND LOW CONCENTRATIONS OF EACH YEAR IN DENTON CREEK (Segment 0825)

☐ = DIATOMS ▨ = GREEN ALGAE

▤ = BLUE-GREEN ALGAE ▦ = FLAGELLATES

(DATA FROM CITY OF DALLAS 1967-1976 b)

Macroinvertebrates - Glass (1950) reported the following aquatic Coleoptera from Denton Creek:

Aquatic Coleoptera of Denton Creek

Organism	Date Collected
Family Gyrinidae	
Gyretes sinuatus Lec.	July 18, 1950
Dineutes americanus Say	February 28, 1950
Family Halipidae	
Peltodytes litoralis Math.	February 28, 1950
Family Hydrophilidae	
Tropisternus lateralis (Fabr.)	February 28, 1950

Moore (1950) reported the mayfly nymph, *Stenonema candidum* Traver., to be abundant in Denton Creek near Belt Line Road. Resh and Unzicker (1975) list *Stenonema* as a genus associated with light to moderate amounts of organic pollution. He also reported *Caenis* sp. from a station just below Grapevine Dam.

Fishes - Fish surveys conducted on Denton Creek were not encountered with two minor exceptions. Hellier (1972) conducted a fish survey on the Elm Fork drainage basin, with one sampling location on Denton Creek near its confluence with the Elm Fork. Data for Denton Creek were not treated separately, however, and high flows precluded quantification (see Table XVIII, Segment 0822).

Fullwood (1950) surveyed copepoda parasitic to fishes in Dallas County. The results for Denton Creek are given in Table XX. No parasites were encountered on fishes taken from Denton Creek.

NONPOINT VS. POINT SOURCE LOADINGS

Segment 0825 is the lower portion of Denton Creek extending from Grapevine Dam to the confluence of Denton Creek and the Elm Fork. The segment is approximately 19 kilometers (12 miles) in length and has a drainage area of approximately 62 square kilometers (24 square miles). A monitoring station (USGS 08055000) is located approximately 6 kilometers (4 miles) below the Grapevine Dam. Two tributaries, Bakers Branch and Cottonwood Branch, drain into Denton Creek, but their drainage areas are small. Reservoir releases virtually account for 100 percent of the streamflow in Denton Creek. Therefore, the water quality of this segment is nearly the same as that of Grapevine Lake.

Historical data show that streamflow at the USGS Grapevine station ranged from less than 0.03 cubic meters per second (1 cfs) to about 28 cubic meters per second (1000 cfs). The median flow (50 percent of the time) is about 2.3 cubic meters per second (80 cfs), and the flow ranges between 1.7 cubic meters per second (60 cfs) to 4.2 cubic meters per second (150 cfs) 50 percent of the time. It is apparent that reservoir

TABLE NO. XX

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR DENTON CREEK (SEGMENT 0825)

(Taken from Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	12	1"-2"
Notropis lutrensis Plains red shiner	93	1¼"-2½"
Ceratichthys vigilax (*Pimephales vigilax* (Baird and Girard)) Bullnose minnow (Bullhead minnow)	59	1"-2½"
Opsopoeodus emiliae Pugnose minnow	11	1"-1½"
Pimephales promelas Southern fathead minnow	17	2½"-3"
Campostoma anomalum Stone roller	42	1½"-3½"
Lepomis macrochirus Blue gill sunfish	58	1½"-5"
Percina caprodes Log perch	11	3"-4½"
Hydropterus scierus (*Percina sciera* (Swain)) Dusky Darter	15	2"-3½"
Poecilichthys spectabilis (*Etheostoma spectabile* (Agassiz)) Plains orange throated darter	30	1¼"-1½"
Megastomatobus cyprinella (*Ictiobus cyprinellus* (Valenciennes)) Big mouth buffalo (Largemouth buffalofish)	10	10"-12"
Cyprinus carpio Carp	46	2"-7"

continued. . .

Species	Number Captured	Size Range
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) black bullhead	28	2½"-8"
Schilbeodes nocturnus (*Nocturus nocturnus* (Jordan and Gilbert)) Freckled madtom	11	1"-3½"
TOTAL	443	

No parasitic Copepoda were observed in or on the fish collected.

releases have been used largely to regulate flow in Denton Creek. In essence, this regulated flow is diverted and treated by water plants for water supplies before it reaches the West Fork.

Very little activity is currently underway in the drainage area of this segment, and a large portion of this area is still open land. Therefore, nonpoint source pollution may not be an important factor affecting water quality in Denton Creek. However, there are presently insufficient data available for conducting any nonpoint source evaluation.

According to TWQB (1975-1976), there are no significant point source discharges within the Denton Creek watershed.

WATER USES

Domestic and Municipal

Denton Creek is heavily used as a source of domestic and municipal water. Water released from Grapevine Lake flows down Denton Creek to the Elm Fork where it is utilized by the City of Dallas and the Dallas County Park Cities Municipal Utility District. The actual withdrawal of water occurs in the Elm Fork of the Trinity River (Segment 0822).

Industrial and Agricultural

The industrial and agricultural uses of water in this segment are the same as those previously mentioned for the Elm Fork Trinity River (Segment 0822).

Recreational

Denton Creek is moderately to lightly used as a source of recreation. Fishing and canoeing, the primary sports in this segment, are dependent upon upstream releases from Grapevine Lake.

SUMMARY

Water quality in Denton Creek is good, and all TWQB (1976a) criteria were met. Nutrient values are relatively low. The water in Denton Creek is moderately hard to hard. All other chemical parameters indicate no problems with regard to water quality. Historical water analyses reveal a good degree of consistency in water quality over the years.

High phytoplankton concentrations are common in Denton Creek. The situation is similar to the one in the Elm Fork. Other biological data, both present and historical, reveal little else.

ADDITIONAL DATA NEEDS

Since both Denton Creek below Grapevine Dam and the Elm Fork below Lewisville Dam convey raw water for municipal supplies in Dallas and adjacent cities, it has long been monitored closely at least with respect to suitability for water supplies. Whenever problems have developed, data have been collected to analyze them. The data have been sufficient to identify historical trends and to make certain distinctions between nonpoint and point source loadings.

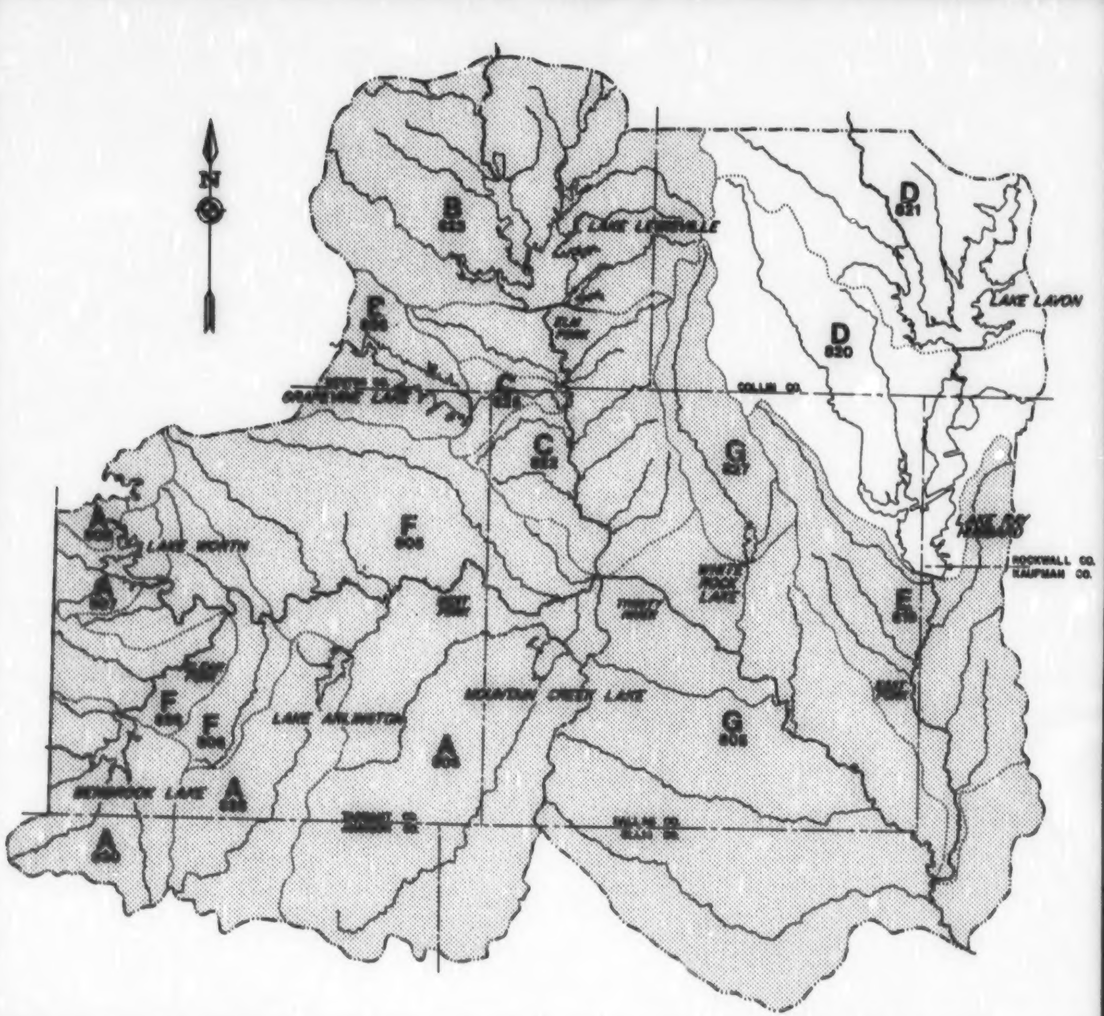
Additional data are required for the kind of nonpoint source analyses to be performed in the current 208 areawide waste treatment management planning project. The data are required primarily on rainfall runoff from areas representative of tributaries and subwatersheds in the Elm Fork and Denton Creek watersheds. The design and implementation of a sampling program to produce such data, and an analysis of those data, are included in the contract under which this report is prepared. The continuing sampling design has been completed and approved. While there are no sampling locations within the Elm Fork or Denton Creek watersheds proper, there are sampling locations which are representative of the nonpoint source characteristics of the Elm Fork and Denton Creek watersheds.

PRESENTATION AREA D

EAST FORK LAKES

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B
LAKE LEWISVILLE
D
821
LAKE LAVON
D
820
E
C
GRAPEVINE LAKE
COLLIN CO.
C
G
F
806
A
LAKE WORTH
A
LAKE RAY HUBBARD
ROCKWALL CO.
KAUFMAN CO.
WHITE ROCK LAKE
E
MOUNTAIN CREEK LAKE
F
F
806
LAKE ARLINGTON
A
G
805
BENBROOK LAKE
A
A

PRESENTATION AREA D - EAST FORK LAKES

SUMMARY

Both Lake Ray Hubbard and Lake Lavon appear to have similar water quality. Lake Lavon data conformed to all TWQB (1976a) standards, while Lake Ray Hubbard exhibited some problem with pH values. In general, dissolved oxygen values were high, nutrients were high relative to other lakes in the area, and fecal coliform counts were low.

Lake Lavon appears to undergo little summer stratification, due largely to its present relative shallowness. On the other hand, Lake Ray Hubbard undergoes substantial summer stratification, resulting in anoxic conditions in the hypolimnion.

Considerable attention has been given to several tributaries entering these two lakes. Rowlett Creek, Ticky Creek, Elm Creek, and Wilson Creek have all been studied continually, due largely to the fact that each of these creeks carries some treated wastewaters.

Lake Ray Hubbard has experienced high phytoplankton counts and problems with taste and odor during the late summer for the past several years. Lake Lavon has much less of a problem on both counts.

Bacteria data indicate no apparent problems in either Lake Ray Hubbard or Lake Lavon. Other biological data are in short supply for both lakes.

Figures D1 and D7 present maps of Lake Ray Hubbard and Lake Lavon, respectively, pinpointing existing monitoring stations.

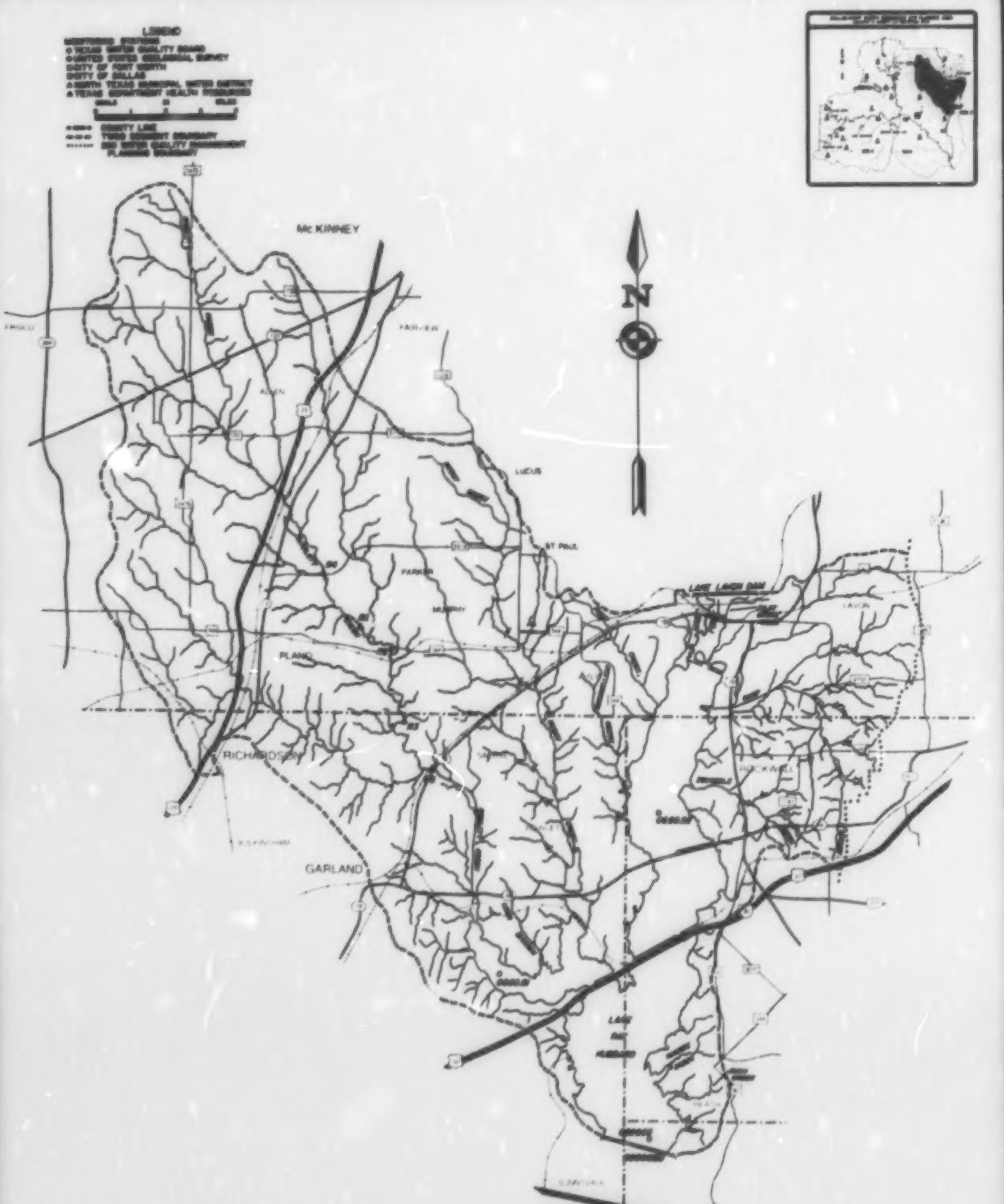
MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Segment 0820			
NT	Rowlett Creek at Los Rios Boulevard	R1	C
NT	Rowlett Creek at FM 544	R2	C
NT	Rowlett Creek at Blackburn Road	R3	C
NT	Rowlett Creek at Parker Road	R4	C
NT	Rowlett Creek at SH 78	R5	C
TWQB	Lake Ray Hubbard, Rowlett Creek Arm	0820.01	CcS
TWQB	Lake Ray Hubbard, East Fork Arm	0820.02	Cc
TWQB	Lake Ray Hubbard at midlake near dam	0820.03	CcBb
USGS	Lake Ray Hubbard near Forney	08061550	RQp
NT	Lake Lavon Intake #1 near dam	L1	A
NT	Lake Lavon Intake #2 at East Fork Harbor	L2	A

continued. . .

Agency	Location	Station Number	Type of Record*
Segment 0821			
NT	Lake Lavon near Garland Power Plant	L3	B
NT	Elm Creek at SH 78	L4	A
NT	Lake Lavon, Pilot Grove Arm	L5	A
NT	Ticky Creek near FM 982	L6	A
NT	Wilson Creek north of Highland Park	L7	A
NT	Lake Lavon, East Fork Arm	L8	A
TWQB	Lake Lavon, East Fork Arm	0821.01	CcS
TWQB	Lake Lavon, Pilot Grove Arm	0821.02	Cd
TWQB	Lake Lavon at midlake near dam	0821.03	Cd
USGS	Lake Lavon near Lavon	08060500	RQp

*The "Type of Record" designations for each Agency are explained under Appendix A, Sources of Information.


LEGEND
MONITORING STATIONS
TEXAS WATER QUALITY BOARD
UNITED STATES GEOLOGICAL SURVEY
CITY OF FORT WORTH
CITY OF DALLAS
NORTH TEXAS MUNICIPAL WATER DISTRICT
TEXAS DEPARTMENT HEALTH RESOURCES
COUNTY LINE
TWQB SEGMENT BOUNDARY
N
McKINNEY
FRISCO
FAIRVIEW
ALLEN
LUCAS
ST PAUL
PARKER
MURPHY
PLANO
RICHARDSON
GARLAND
LAVON
ROCKWALL
LAKE LAVON DAM

PRESENTATION AREA D - Segment 0820

TRINITY RIVER AUTHORITY OF TEXAS — December 1976

Planning and Environmental Management Division — FIGURE D1

LAKE RAY HUBBARD - Segment 0820

Construction of Lake Ray Hubbard began in June 1964, and first achievement of normal capacity occurred during November 1971. It has a capacity of 6.0 x 10^8 cubic meters (4.9 x 10^5 acre-feet) and a surface area of 92.0 square kilometers (22,745 acres) at an elevation of 132.7 meters (435.5 feet) above mean sea level. The mean depth of Lake Ray Hubbard is 6.55 meters (21.5 feet).

There is a sizeable limnologic study of Lake Ray Hubbard underway at the time this report is being prepared. It is being performed by the City of Dallas Water Utilities Department and the University of Texas at Dallas as a part of the same planning project of which this report is a part. The project began in late spring 1976, and will continue through one annual cycle. Samples are collected at representative locations and depths throughout the lake and on streams entering the lake. Samples are analyzed for a variety of physical, chemical, and biological parameters. Particular emphasis is placed on factors involved in eutrophication. Analyses of the data, including a calculation of the lake nutrient budget and the results of mathematical modeling of eutrophication, are expected. Since the study will be completed and reported later as a part of the same overall planning project, no data or interim results are in this report. All other available data are presented here, as on other lake and stream segments. Since, as noted below, these other available data are quite limited, it is expected that the current study, when complete, should largely supercede in comprehensiveness this section on Lake Ray Hubbard. A map of Lake Ray Hubbard and its watershed, pinpointing monitoring stations, is presented in Figure D1.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Lake Ray Hubbard (TWQB 0820.01, 0820.02, 0820.03 USGS 08061550). All concentrations are in mg/l, unless otherwise specified. All samples are surface grab samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	18.4	32.0	7.3	9.1	45
Dissolved Oxygen	9.5	12.3	7.1	1.7	42
pH (pH units)	8.2	9.1	7.0	0.4	43
Conductivity (umhos/cm)	317	420	240	39	44
Total Suspended Solids	17	48	1	**	41
Volatile Suspended Solids	10	36	1	**	41
Total Dissolved Solids	162	210	130	21	29
Ammonia, as N	0.16	0.8	0	**	42
Nitrite, as N	0.027	1.00	0.00	**	39
Nitrate, as N	0.26	1.00	0.00	**	42
Total Phosphate, as P	0.20	1.00	0.00	**	42
Orthophosphate, as P	0.09	0.50	0.00	**	42

continued. . .

Parameter	Mean	Max	Min	S	N
Chloride, as Cl	13	22	6	5	43
Sulfate, as SO_4	26	44	6	7	43
Chlorophyll a (ug/l)	13	62	1	**	42
Secchi (cm)	83	213	0	**	42
Fecal Coliform (#/100 ml)	6*	342	0	**	22
Total Organic Carbon	5	10	1	**	13
Total Hardness, as $CaCO_3$	120	120	120	-	1
Noncarbonate Hardness, as $CaCO_3$	12	12	12	-	1
Sodium Absorption Ratio, SAR	0.4	0.4	0.4	-	1
Bicarbonate, as HCO_3	128	128	128	-	1
Carbonate, as CO_3	0	0	0	-	1
Calcium, as Ca	41	41	41	-	1
Fluoride, as F	0.3	0.3	0.3	-	1
Magnesium, as Mg	3.5	3.5	3.5	-	1
Manganese, as Mn	0.50	0.50	0.50	-	1
Potassium, as K	3.4	3.4	3.4	-	1
Silica, as SiO_2	3.3	3.3	3.3	-	1
Sodium, as Na	11	11	11	-	1

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in Lake Ray Hubbard were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.

Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.

pH- Acceptable range: 7.0-9.0. Criterion not met. The maximum value reported was 9.1 at TWQB station 0820.01 in December, 1974. The pH violation occurred only once and at only one station. This station was in the Rowlett Creek arm of the lake and would not represent pH values for the lake as a whole.

Total Dissolved Solids - Mean concentration not to exceed 300 mg/l. Criterion met (no reported values exceeded 300 mg/l).

Chloride - Mean concentration not to exceed 40 mg/l. Criterion met (no reported values exceeded 40 mg/l).

Sulfate - Mean concentration not to exceed 40 mg/l. Criterion met (a maximum of 44 mg/l was reported).

Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Figures D2 and D3 present typical summer and winter vertical profiles in Lake Ray Hubbard for the parameters dissolved oxygen, temperature, and pH. A surface-to-bottom temperature difference of 7-8 °C and near-anoxic conditions below about eight meters appears to be the case in Lake Ray Hubbard during the late summer.

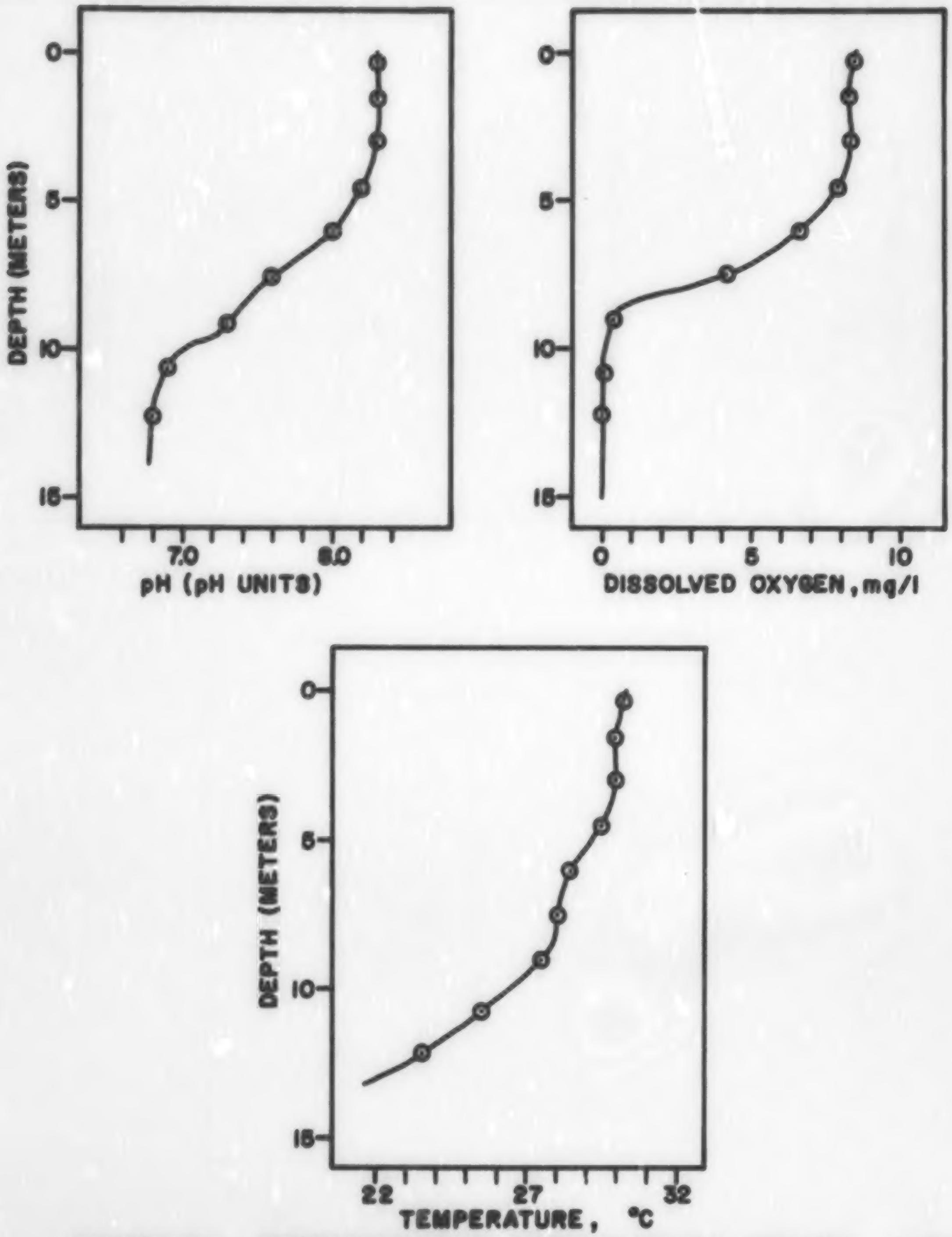


FIGURE D2. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN LAKE RAY HUBBARD FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON JULY 30, 1975 (TIME 1215).
(DATA FROM TWQB 0820.03)

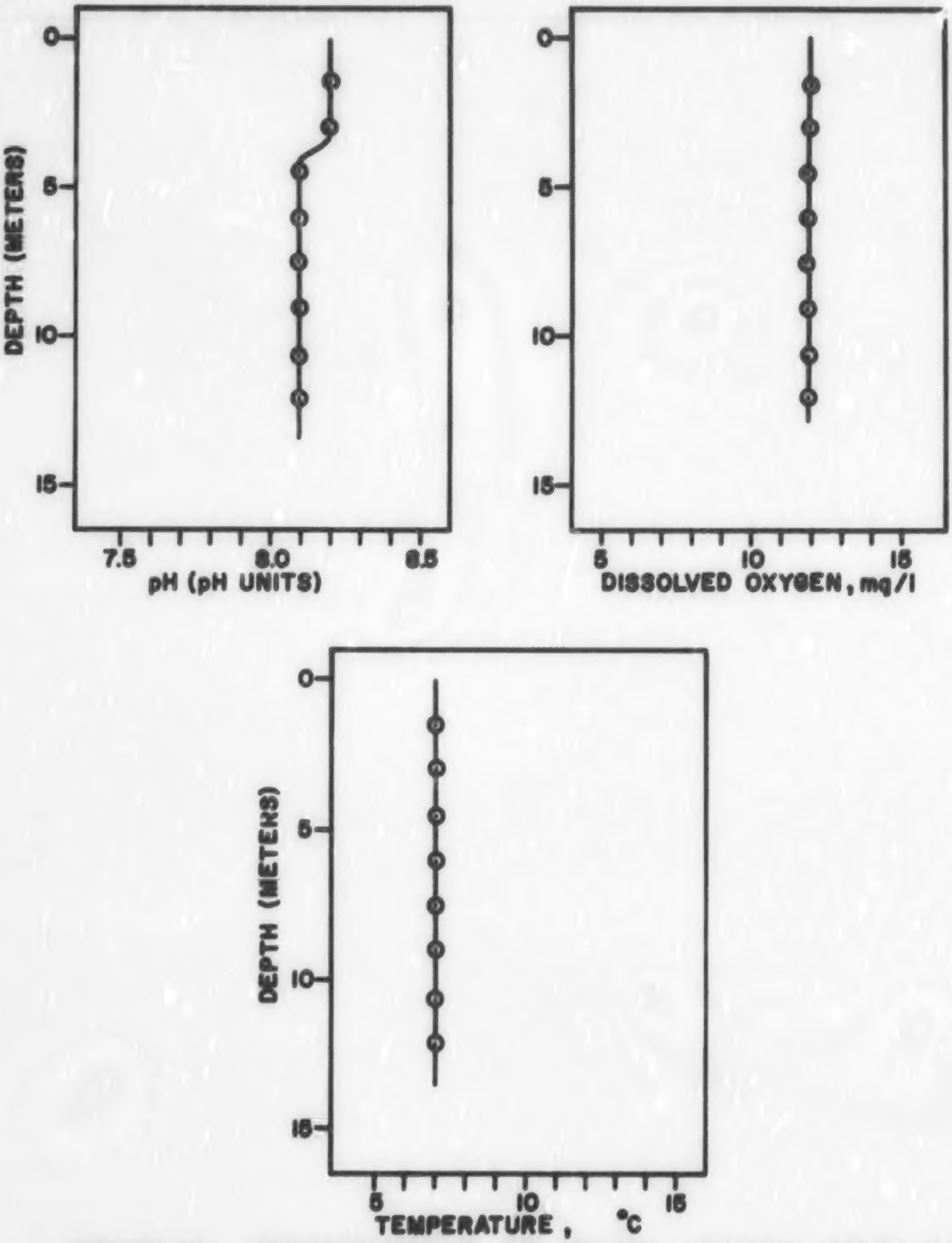


FIGURE D3. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN LAKE RAY HUBBARD FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON JANUARY 29, 1976 (TIME 1030).

(DATA FROM TWQB 0820.03)

Water quality in Lake Ray Hubbard appears to be affected by the algae present. Chlorophyll a values ran as high as 62 ug/l, indicating very eutrophic conditions. Nutrients are plentiful enough to sustain large phytoplankton populations. In addition, Lake Ray Hubbard has been known to have taste and odor problems relating to algae.

Tributary Water Analyses - Tributaries entering Lake Ray Hubbard include Rush Creek (Rockwall County), Yankee Creek, Squabble Creek, Camp Creek, Pilot Grove Creek, East Fork Trinity River below Lavon Dam, Rush Creek (Collin County), Cottonwood Creek, Muddy Creek, Long Branch, and Rowlett Creek.

Rowlett Creek has been sampled extensively by the North Texas Municipal Water District (NTMWD) since April 1, 1976. The following table summarizes recent water quality for Rowlett Creek. All concentrations are in mg/l, unless otherwise specified.

Rowlett Creek Water Quality
(NTMWD R1, R2, R3, R4, R5)
(4-1-76 through 6-30-76)

Parameter	Mean	Max	Min	S	N
Temperature (C)	21.6	24.0	18.5	1.7	45
Dissolved Oxygen	6.6	7.8	2.7	0.7	45
pH (pH units)	7.6	8.0	7.0	0.2	45
Conductivity (umhos/cm)	448	660	280	74	45
Total Suspended Solids	69	288	5	**	45
Volatile Suspended Solids	37	85	8	**	15
Total Dissolved Solids	290	462	175	75	45
Total Alkalinity, as $CaCO_3$	133	165	90	23	18
Total Hardness, as $CaCO_3$	180	204	152	16	18
Chloride, as Cl	26	54	5	9	45
Sulfate, as SO_4	69	159	18	**	45
Ammonia, as N	5.80	29.7	0.15	**	44
Nitrite, as N	0.03	0.11	0.00	3	15
Nitrate, as N	0.86	1.56	0.00	0.41	15
Organic Nitrogen, as N	0.06	0.06	0.06	-	1
Orthophosphate, as P	1.07	4.10	0.01	**	45
Biochemical Oxygen $Demand_5$	6	29	1	**	45
Fecal Coliform (#/100 ml)	1880	19200	0	**	41
Total Coliform (#/100 ml)	$3.0x10^5$	$3.4x10^6$	80	**	18
Turbidity (NTU)	245	480	64	**	14

-Standard deviation not computed when N is less than six.
**Data from a clearly non-normal distribution; no standard deviation computed.

Figure D4 presents a profile of Rowlett Creek for the parameters chloride, sulfate, and fecal coliform. Other parameters such as BOD, total coliform, ammonia, and phosphate showed trends similar to those exhibited by chloride and sulfate.

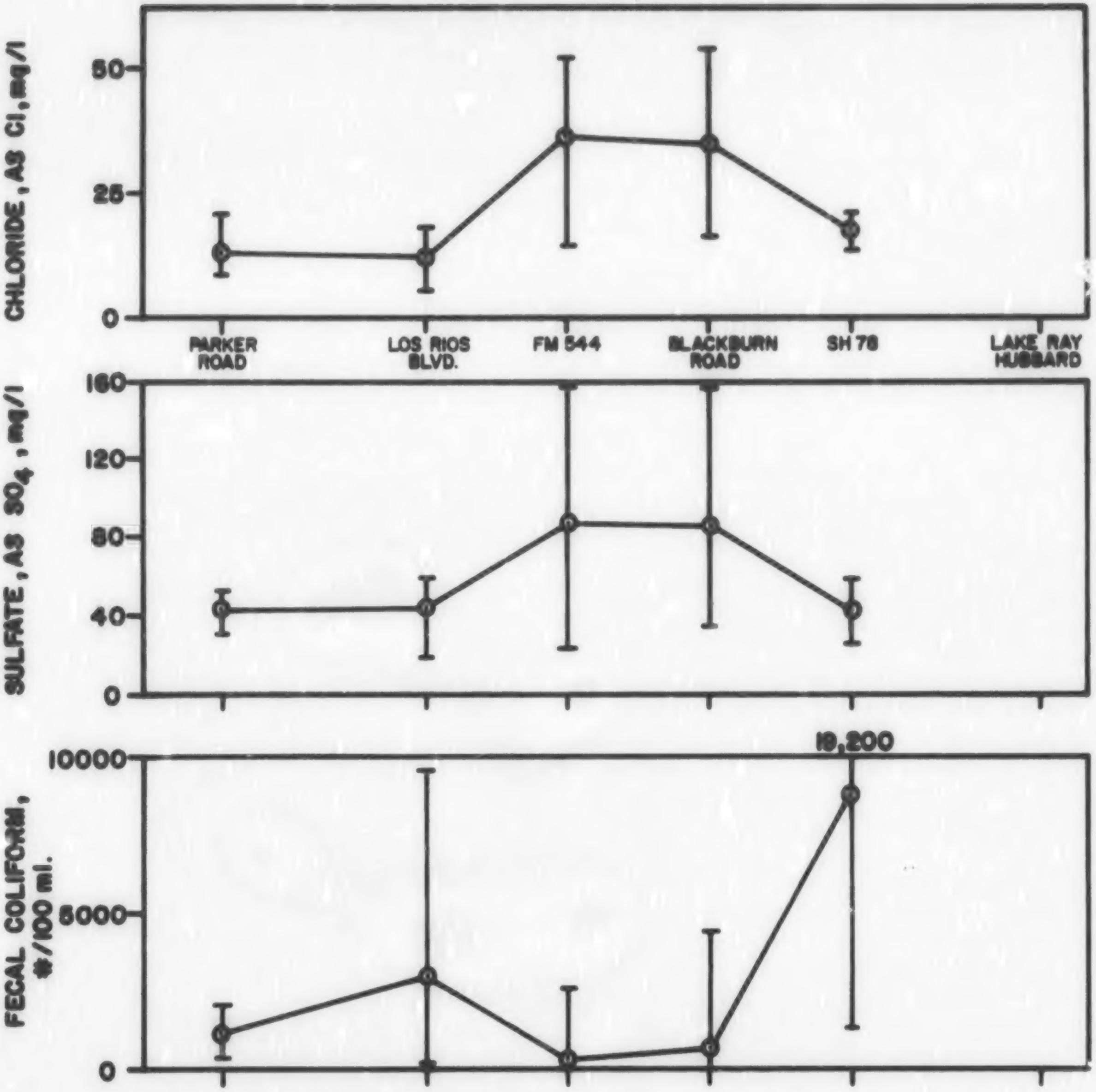


FIGURE D4. ROWLETT CREEK PROFILES FOR CHLORIDE, SULFATE, AND FECAL COLIFORM. VALUES PLOTTED ARE MEANS AND RANGES, AND THE PERIOD COVERED IS FROM 4-1-76 THROUGH 6-30-76. (DATA FROM NTMWD 1975)

Sediment Analyses - The TWQB conducts periodic sediment analyses at one station (TWQB 0820.01) in Lake Ray Hubbard. The following table summarizes recent sediment analyses. All concentrations are in mg/kg (dry weight), unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Oil and Grease	343	460	226	-	2
Organic Nitrogen	1640	1640	1640	-	1
Phosphorus in Particulates	1400	2400	400	-	2
Arsenic, as As	4.5	6.4	2.61	-	2
Barium, as Ba	99	99	99	-	1
Boron, as B	0.00	0.00	0.00	-	1
Cadmium, as Cd	0.9	1.00	0.80	-	2
Chromium, as Cr	28.6	42.0	15.1	-	2
Copper, as Cu	15.1	23.0	7.19	-	2
Lead, as Pb	22.2	25.0	19.3	-	2
Manganese, as Mn	492	750	235	-	2
Mercury, as Hg (mg/kg, wet wt.)	0.05	0.1	0.0	-	2
Nickel, as Ni	20	33	6.8	-	2
Selenium, as Se	0.53	0.53	0.53	-	1
Silver, as Ag	1.5	1.93	1.0	-	2
Zinc, as Zn	59	87	30.4	-	2

-Standard deviation not computed when N is less than six.

Biological
(10-1-74 through 6-30-76)

Bacteria - Fecal coliform data were summarized for Lake Ray Hubbard in the WATER ANALYSES table. The data produced a log. mean of 6 organisms/100 ml. This, along with a reported maximum of 342 organisms/100 ml, indicates no bacterial problem. Data for total coliform and other types of bacteria were unavailable.

In addition, fecal and total coliform summaries were presented above in the water quality summary for Rowlett Creek. The mean and maximum fecal concentrations were 1880 organisms/100 ml and 19,200 organisms/100 ml respectively. It is apparent that Rowlett Creek serves as a source of fecal contamination for the lake, principally a direct result of receiving sewage effluents from two sewage treatment plants (Plano and Garland Rowlett Creek). This contamination does not appear to greatly affect concentrations in the lake, however, as evidenced by the lake log. mean of six organisms/100 ml.

Plankton - Recent phytoplankton and zooplankton analyses will best be covered with the results of the City of Dallas/UTD Ray Hubbard study, when they become available. Treatment of phytoplankton in this report will be limited to historical data and trends.

No other recent biological data were encountered for Lake Ray Hubbard.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Historical trends for chlorophyll *a*, chloride, and nitrate are presented for Lake Ray Hubbard in Figure D5. It may be noted that both chlorophyll *a* and nitrate exhibit similar trends, and that both show an annual cycle. Surface concentrations of both chlorophyll *a* and nitrate are low during the late summer, due to loss of nutrients to the hypolimnion and decreasing insolation (chlorophyll *a*, only). Conversely, values are high during late fall and early spring following "turnover" and resuspension and subsequent oxidation of reduced nutrients ($NH_3+NO_2+NO_3$). Chloride concentrations are fairly low and relatively constant, excluding one datum. The high values for nutrients and chlorophyll generally come from the Rowlett Creek Arm of the Lake.

Tributary Water Analyses - Insufficient data exist for the examination of trends in water quality for Rowlett Creek and other tributaries entering Lake Ray Hubbard.

Sediment Analyses - TWQB (1974c) reports the following sediment pollutant concentrations for Lake Ray Hubbard. All concentrations are mg/kg, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Chemical Oxygen Demand	50900	56330	49240	6398	6
Kjeldahl Nitrogen	1750	2120	1350	300	6
Oil and Grease	450	540	360	64	6
Total Phosphate	2500	2800	1700	390	6
Volatile Solids	6.9	7.5	5.9	0.7	6
Aldrin (ug/kg)	0	0	0	0	6
Chlordane (ug/kg)	0	0	0	0	6
DDD (ug/kg)	0.5	0.9	0.0	**	6
DDE (ug/kg)	2.0	3.0	1.0	1.0	6
DDT (ug/kg)	0	0	0	0	6
Diazinon (ug/kg)	0	0	0	0	6
Dieldrin (ug/kg)	0	0	0	0	6
Endrin (ug/kg)	0	0	0	0	6
Heptachlor (ug/kg)	0	0	0	0	6
Heptachlor Epoxide (ug/kg)	0	0	0	0	6
Lindane (ug/kg)	0	0	0	0	6
Methoxychlor (ug/kg)	0	0	0	0	6
Methyl Parathion (ug/kg)	0	0	0	0	6
Parathion (ug/kg)	0	0	0	0	6
Silvex (ug/kg)	0	0	0	0	6
Toxaphene (ug/kg)	0	0	0	0	6
PCB (ug/kg)	0	0	0	0	6
Arsenic, as As (ug/kg)	3.9	7.3	2.6	1.7	6
Cadmium, as Cd	<1.0	1.0	<1.0	<0.41	6
Copper, as Cu	17	24	11	4	6
Chromium, as Cr	38	46	26	7	6

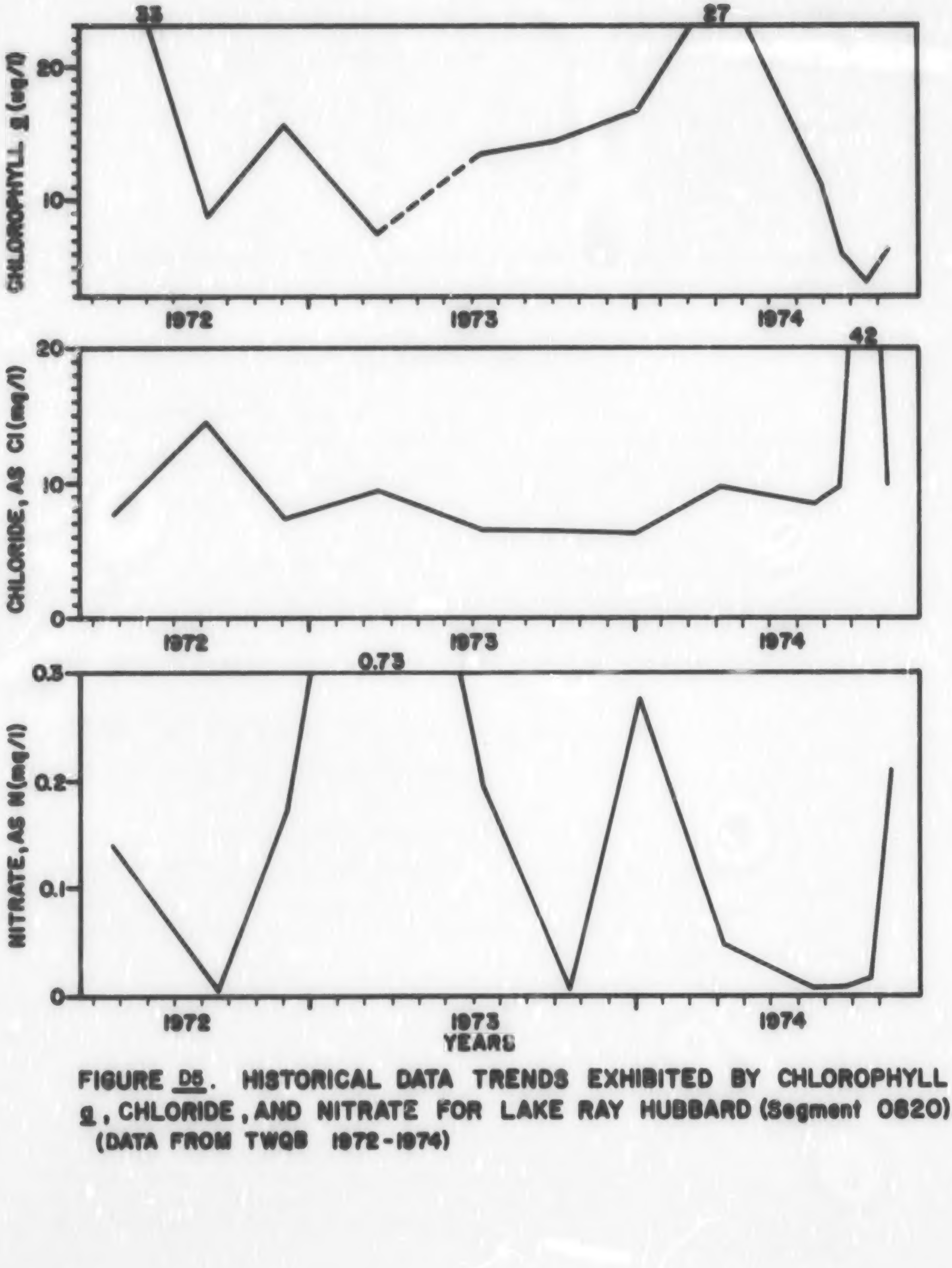


FIGURE D5. HISTORICAL DATA TRENDS EXHIBITED BY CHLOROPHYLL a, CHLORIDE, AND NITRATE FOR LAKE RAY HUBBARD (Segment 0820). (DATA FROM TWQB 1972-1974)

continued. . .

Parameter	Mean	Max	Min	S	N
Lead, as Pb	18	21	15	3	6
Manganese, as Mn	530	770	410	170	6
Mercury, as Hg	0.020	0.030	0.003	0.009	6
Nickle, as Ni	26	38	19	6	6
Silver, as Ag	1	2	1	1	6
Zinc, as Zn	73	90	60	10	6

**Distribution of values clearly non-normal; no standard deviation computed.

Biological
(Prior to 10-1-74)

Bacteria - Lake Ray Hubbard appears to have had no problem with fecal coliform concentrations in the past. TWQB data only go back to 1973, with about three analyses per station per year. Also, the Rowlett Creek Arm station (TWQB 0820.01) appears to have fecal coliform counts with no significant difference to other Lake Ray Hubbard stations.

Plankton - As mentioned previously, Lake Ray Hubbard has had a history of problems with high phytoplankton concentrations. Figure D6 presents phytoplankton trends for the period 1971 through 1973. The high proportion of blue-green algae present during late summer "blooms" is largely responsible for taste and odor problems common to Lake Ray Hubbard.

No other historical biological data were encountered for Lake Ray Hubbard.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering Lake Ray Hubbard. However, there are one industrial and four domestic point sources with a flow in excess of 0.002 cubic meters per second within this watershed, according to TWQB (1975-1976).

WATER USES

Domestic and Municipal

Lake Ray Hubbard is very heavily used for domestic and municipal water supplies. The sole user of the water is the City of Dallas. Water rights permits for domestic and municipal withdrawals for this segment total 9.8 x 10^7 cubic meters per year. (79,700 acre-feet per year). The dependable yield for this lake, according to TWDB (1977), totaled 2.86 cubic meters per second (64.8 MGD).

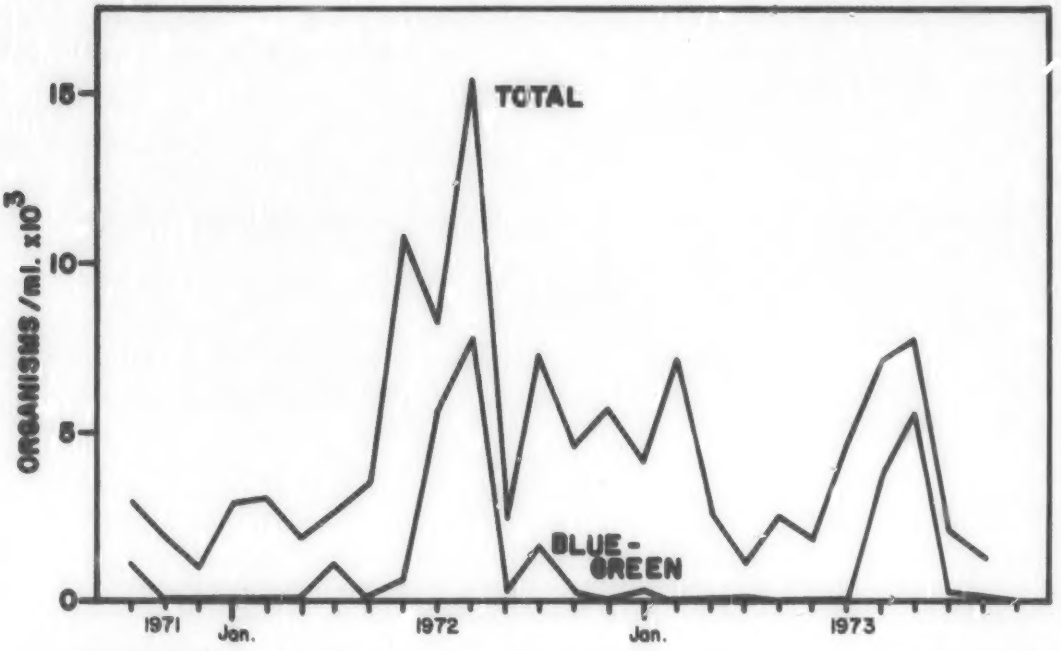


FIGURE D6. HISTORICAL TRENDS EXHIBITED BY TOTAL AND BLUE-GREEN ALGAE FROM LAKE RAY HUBBARD (Segment 0820).

(DATA FROM CITY OF DALLAS 1971-1973)

Industrial

Lake Ray Hubbard is moderately used as an industrial water supply. The sole user is Dallas Power and Light Company. Water rights permits for industrial withdrawal from this segment total 1.23×10^7 cubic meters (10,000 acre-feet) per year. The use of this water is for cooling electrical generator steam condensing towers, and in doing so a calculated average of 0.09 cubic meters per second (2.1 MGD) is consumed by evaporation. In addition, some of the water removed for domestic and municipal use may be consumed by local industry.

Agricultural

According to NCTCOG (1974), the waters of Lake Ray Hubbard are not used as an agricultural water supply.

Recreational

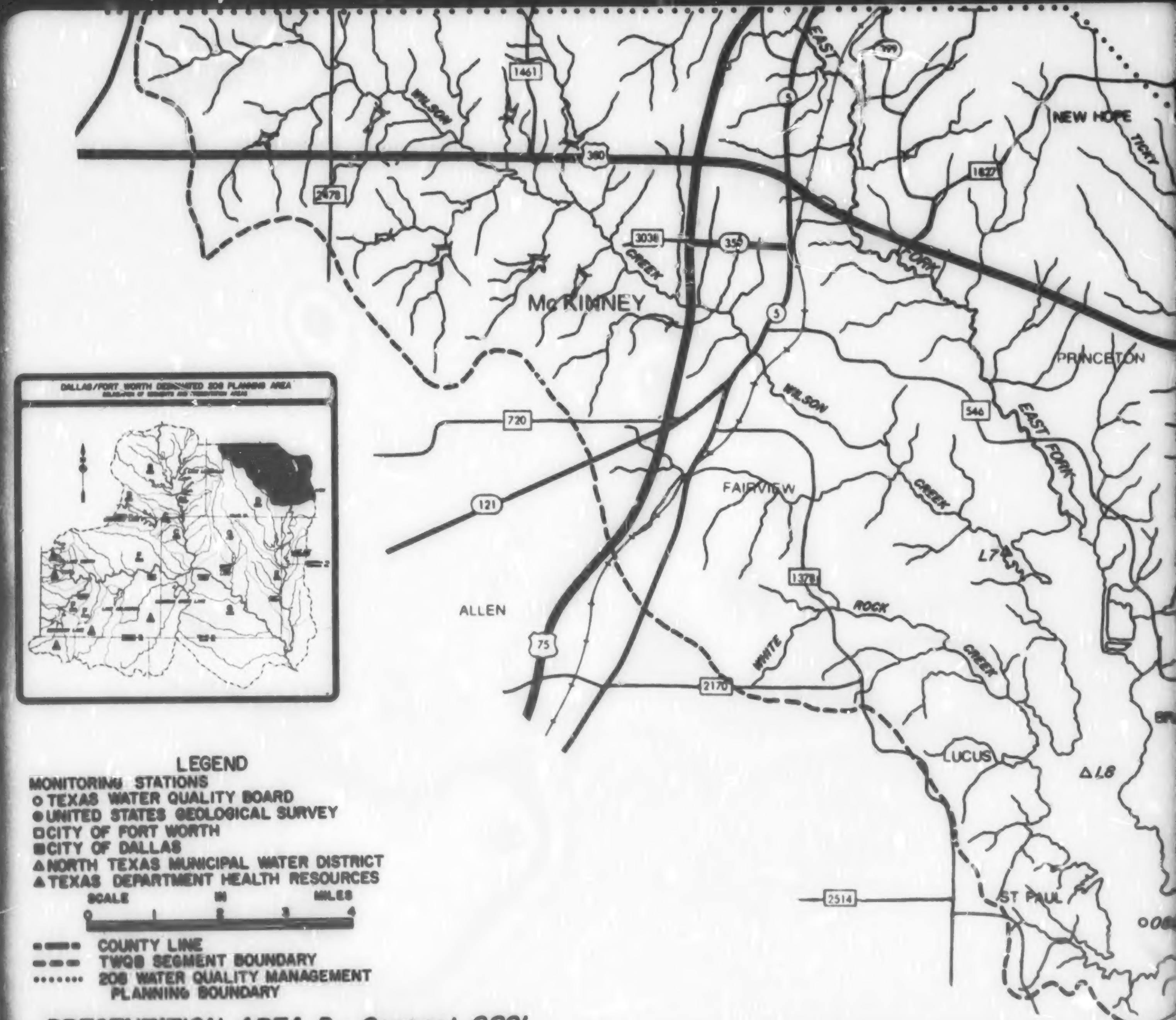
Lake Ray Hubbard is heavily used for recreation. Activities on and near the lake include fishing, boating, camping, water skiing, and hiking.

SUMMARY

Water quality in Lake Ray Hubbard is good with a few exceptions. All of the TWQB (1976a) criteria were met, except for the one regarding pH. However, this violation was from only one reading taken in an area considered atypical of the lake as a whole. Also, nutrient concentrations are relatively high. Other parameters reveal little problem with water quality. Lake Ray Hubbard undergoes significant summer stratification.

Much of the nutrient loading appears to come from tributaries entering the lake, such as Rowlett Creek, which carries sewage effluent from two sewage treatment plants. Few sediment data exist.

Biological data exist for bacteria and phytoplankton. While no problem exists for the former, the latter has produced problems with taste and odor for years.


1461
WILSON
380
2478
3038
35
CREEK
McKINNEY
5
EAST
NEW HOPE
TICKY
1827
FORK
PRINCETON
WILSON
546
EAST FORK
720
121
FAIRVIEW
CREEK
L7
1378
ROCK
CREEK
WHITE
ALLEN
75
2170
LUCUS
△L8
2514
ST PAUL
DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA
LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY

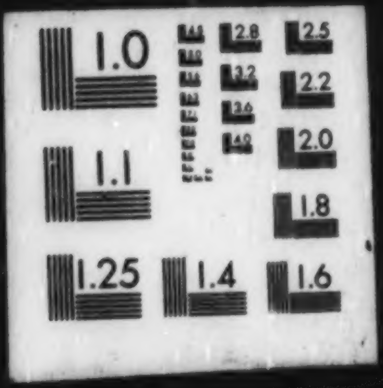
PRESENTATION AREA D - Segment 0821

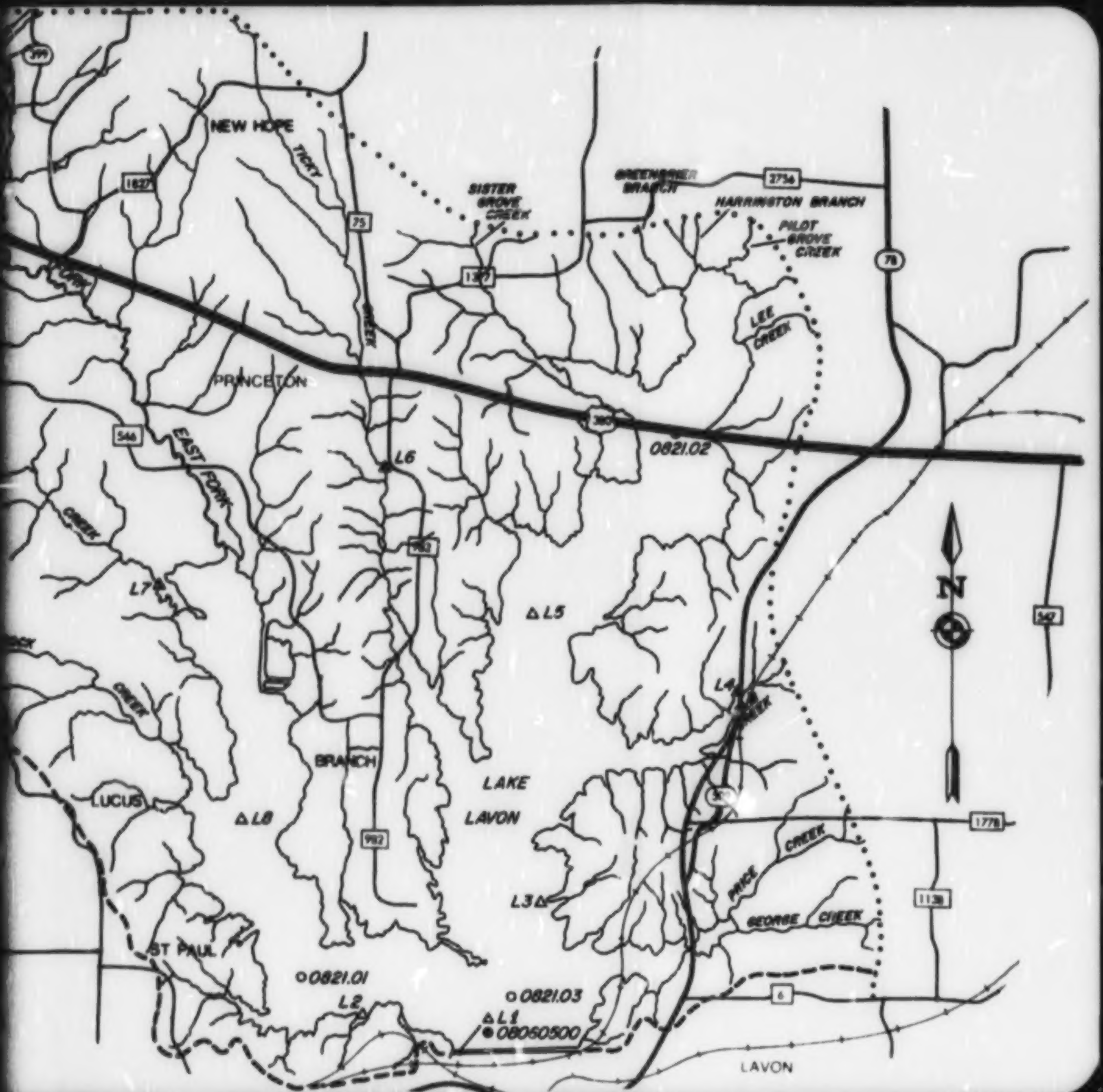
TRINITY RIVER AUTHORITY OF TEXA
Planning and Environmental Management Di

3 OF 4

PB

271 10


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6


399
NEW HOPE
TICKY
1827
75
SISTER GROVE CREEK
GREENBRIER BRANCH
2756
HARRINGTON BRANCH
PILOT GROVE CREEK
78
1377
FORK
CREEK
LEE CREEK
PRINCETON
380
546
EAST FORK
L6
0821.02
CREEK
982
L7
L5
N
547
L4
CREEK
CREEK
BRANCH
LAKE LAVON
LUCUS
L8
982
1778
PRICE CREEK
L3
1138
GEORGE CREEK
ST PAUL
0821.01
0821.03
L2
L1
08060500
6
LAVON

TY OF TEXAS December 1976
Management Division FIGURE D7

LAKE LAVON - Segment 0821

Lake Lavon was constructed during the period 1948-1953, and normal capacity was first achieved in May 1955. The original capacity of Lake Lavon was 1.77 x 10^8 cubic meters (143,600 acre-feet) at an elevation of 143.9 meters (472.0 feet) above mean sea level. In early 1970, construction was initiated to raise the lake elevation from 143.9 meters (472.0 feet) to 150.0 meters (492.0 feet). This construction has now been completed and the Lake Lavon gates were closed to initiate re-impoundment in December 1975. To date, Lake Lavon is at an approximate elevation of 149 meters (488 feet) above mean sea level. Lake Lavon, upon achievement of capacity at an elevation of 150.0 meters (492.0 feet), will have a volume of 5.63 x 10^8 cubic meters (456,500 acre-feet) and a surface area of 86.6 square kilometers (21,400 acres). Lake Lavon has a drainage area of 1990 square kilometers (770 square miles).

A map of Lake Lavon and its watershed, showing existing monitoring stations, is presented in Figure D7.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Lake Lavon (TWQB 0821.01, 0821.02, 0821.03; NTMWD L1, L2, L3, L5, L8). All concentrations are in mg/l, unless otherwise specified. All samples are surface grab samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.3	28.5	7.0	6.1	42
Dissolved Oxygen	8.0	12.1	5.4	1.7	47
pH (pH units)	8.2	8.6	7.5	0.3	56
Conductivity (umhos/cm)	331	420	220	37	49
Total Suspended Solids	28	70	3	**	14
Volatile Suspended Solids	9	36	3	**	14
Total Dissolved Solids	245	350	160	66	45
Ammonia, as N	0.21	0.80	0.00	**	14
Nitrate, as N	0.24	0.63	0.00	**	45
Total Phosphate, as P	0.14	1.02	0.02	**	30
Orthophosphate, as P	0.28	1.05	0.05	**	45
Chloride, as Cl	12	19	5	4	45
Sulfate, as SO_4	30	58	10	9	45
Total Alkalinity, as $CaCO_3$	127	140	119	5	44
Total Hardness, as $CaCO_3$	147	168	140	8	41
Noncarbonate Hardness, as $CaCO_3$	20	23	16	-	3
Chlorophyll a (ug/l)	5	9	2	2	12
Fecal Coliform (#/100 ml)	1.2*	6	0	**	14
Total Coliform (#/100 ml)	2230	8400	120	**	20
Turbidity (NTU)	179	420	75	**	30
Aluminum, as Al	0	0	0	-	3
Bicarbonate, as HCO_3	181	188	171	-	3
Cadmium, as Cd	0	0	0	-	3
Calcium, as Ca	53	56	48	-	3

continued. . .

Parameter	Mean	Max	Min	S	N
Chromium, as Cr	0	0	0	-	3
Copper, as Cu	0.11	0.34	0.00	-	3
Fluoride, as F	0.36	0.41	0.31	-	3
Hydroxide, as OH	9.3	27.9	0.0	-	3
Iron, as Fe	0.39	0.53	0.29	-	3
Magnesium, as Mg	3.9	4.88	3.41	-	3
Lead, as Pb	0	0	0	-	3
Mercury, as Hg	0	0	0	-	3
Nickel, as Ni	0	0	0	-	3
Silver, as Ag	0	0	0	-	3
Sodium, as Na	21.58	23.03	19.42	-	3
Tin, as Sn	0	0	0	-	3
Zinc, as Zn	0	0	0	-	3

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; standard deviation not computed.

Water Quality Standards - These standards for water quality in Lake Lavon were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH- Acceptable range: 7.0-9.0. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 300 mg/l. Criterion met.
Chloride - Mean concentration not to exceed 40 mg/l. Criterion met (no reported values were in excess of 40 mg/l).
Sulfate - Mean concentration not to exceed 40 mg/l. Criterion met.
Fecal Coliform - Logarithmic mean not to exceed 200 organisms/100 ml. Criterion met.

Lake Lavon vertical profiles for the parameters dissolved oxygen, temperature, and pH are presented in Figures D8 and D9 for winter and summer, respectively. It may be seen that very little temperature stratification exists during the summer. This is apparently due to the recent relative shallowness in Lake Lavon. When Lake Lavon reaches capacity at the 150.0 meter elevation, the mean depth will increase to 6.5 meters (21.3 feet), virtually the same as Lake Ray Hubbard. At that time, Lake Lavon will more than likely exhibit stratification patterns more similar to those in Lake Ray Hubbard. At present, some dissolved oxygen and pH stratification is noticeable.

Tributary Water Analyses - The tributaries of Lake Lavon include George Creek, Price Creek, Elm Creek, Lee Creek, Pilot Grove Creek, Harrington Branch, Greenbrier Branch, Sister Grove Creek, Ticky Creek,

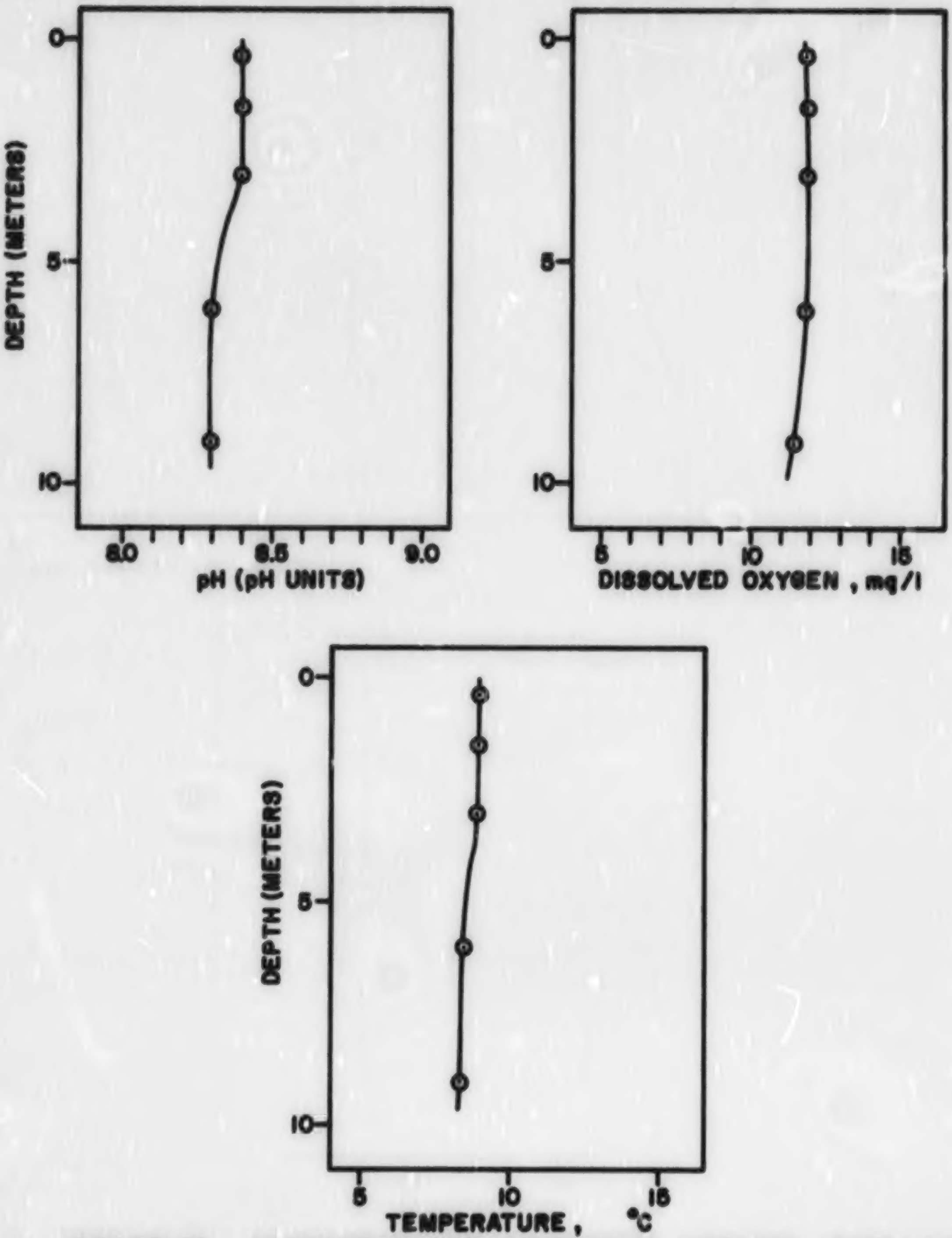


FIGURE D8. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN LAKE LAVON FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON FEBRUARY 27, 1975 (TIME 1150).
(DATA FROM TWQB 0821.03)

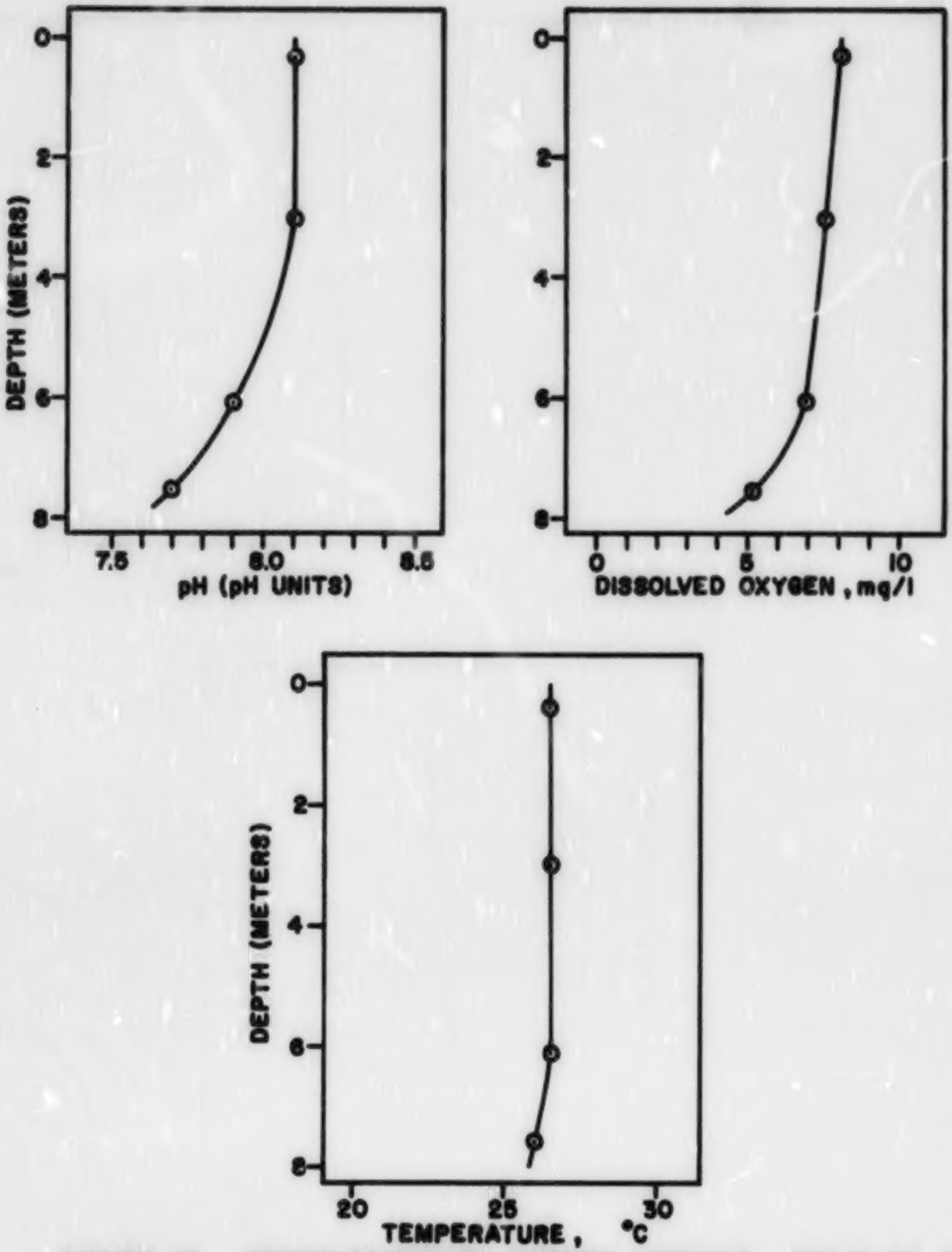


FIGURE D9. REPRESENTATIVE SUMMER VERTICAL PROFILES IN LAKE LAVON FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON AUGUST 22, 1974 (TIME 0915).
(DATA FROM TWQB 0821.03)

East Fork Trinity River, Wilson Creek, and White Rock Creek. The USGS operates a gaging station on the East Fork above Lake Lavon (USGS 08059000). This station has a drainage area of 492 square kilometers (190 square miles) and recorded an average discharge of 7.53 square meters per second (266 cfs) during WY 1975. NTMWD monitors the water quality on three of the tributaries: Wilson Creek (L7), Ticky Creek (L6), and Elm Creek (L4). The following tables are a summary of the recent data from these monitors. All concentrations are in mg/l, unless otherwise specified.

Water Quality of
Wilson Creek North of Highland Park
(Data from NTMWD 1975-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	18.0	24.0	14.0	1.4	6
Dissolved Oxygen	6.8	9.6	5.2	0.7	6
pH (pH units)	7.6	7.8	7.4	0.1	6
Conductivity (umhos/cm)	513	660	470	56	6
Total Suspended Solids	67	88	45	-	3
Volatile Suspended Solids	26	31	21	-	2
Total Dissolved Solids	325	393	274	-	3
Ammonia, as N	14.4	44.8	1.3	**	6
Nitrite, as N	0.06	0.08	0.04	-	2
Nitrate, as N	0.37	0.37	0.37	-	2
Orthophosphate, as P	4.0	8.9	1.4	-	3
Chloride, as Cl	34.0	51.8	25.0	7.5	6
Sulfate, as SO_4	47.7	54.0	31.1	7.3	6
Total Alkalinity, as $CaCO_3$	168	171	164	-	2
Total Hardness, as $CaCO_3$	195	200	190	-	2
Fecal Coliform (#/100 ml)	230	430	0	**	6
Total Coliform (#/100 ml)	88200	88200	88200	-	2
Biochemical Oxygen Demand$_5$	7.3	10.0	5.0	1.3	6
Turbidity (NTU)	160	180	140	-	2

-Standard deviation not computed when N is less than six.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality of
Ticky Creek Near FM 982
(Data from NTMWD 1975-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	18.8	24.0	15.0	1.3	6
Dissolved Oxygen	8.2	9.8	7.0	-	3
pH (pH units)	8.0	8.5	7.7	-	3
Conductivity (umhos/cm)	551	670	440	51	6
Total Suspended Solids	46	85	22	-	3
Volatile Suspended Solids	33	33	33	-	1
Total Dissolved Solids	302	331	284	-	3
Ammonia, as N	6.9	12.4	1.6	1.5	6

continued. . .

Parameter	Mean	Max	Min	S	N
Nitrite, as N	0.18	0.35	0.00	-	2
Nitrate, as N	0.00	0.00	0.00	-	2
Orthophosphate, as P	6.78	8.40	5.13	-	3
Chloride, as Cl	46	60	29	**	6
Sulfate, as SO_4	80	94	69	7	6
Total Alkalinity, as $CaCO_3$	151	152	150	-	2
Total Hardness, as $CaCO_3$	147	148	146	-	2
Fecal Coliform (#/100 ml)	485	900	20	**	6
Total Coliform (#/100 ml)	182933	182933	182933	-	1
Biochemical Oxygen Demand$_5$	12	24	4	5.3	6
Turbidity (NTU)	121	153	90	-	3

-Standard deviation not computed when N is less than six.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality of
Elm Creek at SH 78
(Data from NTMWD 1975-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.8	24.0	19.0	-	3
Dissolved Oxygen	8.2	9.8	7.0	-	3
pH (pH units)	8.0	8.5	7.7	-	3
Conductivity (umhos/cm)	590	660	550	-	3
Total Suspended Solids	146	298	48	-	3
Volatile Suspended Solids	38	49	27	-	3
Total Dissolved Solids	379	416	316	-	3
Ammonia, as N	1.9	2.7	1.3	-	3
Nitrite, as N	0.03	0.05	0.01	-	2
Nitrate, as N	0.74	1.06	0.42	-	2
Orthophosphate, as P	2.87	5.90	1.17	-	3
Chloride, as Cl	83	172	36	-	3
Sulfate, as SO_4	78	93	69	-	3
Total Alkalinity, as $CaCO_3$	216	219	212	-	2
Total Hardness, as $CaCO_3$	254	254	254	-	2
Fecal Coliform (#/100 ml)	17700	35280	200	-	2
Total Coliform (#/100 ml)	228300	411600	45080	-	2
Biochemical Oxygen Demand$_5$	9	14	3	-	3
Turbidity (NTU)	180	184	175	-	2

-No standard deviation calculated when N is less than six.

No other recent data concerning the tributaries of this segment were encountered.

Sediment Analyses - The following sediment analyses were taken from TWQB (1975-1976) (TWQB 0821.01). All concentrations are in mg/kg (dry weight basis), unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Oil and Grease	510	510	510	-	1
Organic Nitrogen	2190	2190	2190	-	1
Phosphorus in Particulates	2400	2400	2400	-	1
Arsenic, as As	11	11	11	-	1
Cadmium, as Cd	1	1	1	-	1
Chromium, as Cr	43	43	43	-	1
Copper, as Cu	17	17	17	-	1
Lead, as Pb	21	21	21	-	1
Manganese, as Mn	590	590	590	-	1
Mercury, as Hg	0.0	0.0	0.0	-	1
Nickel, as Ni	32	32	32	-	1
Silver, as Ag	1	1	1	-	1
Zinc, as Zn	98	98	98	-	1

-No standard deviation calculated when N is less than six.

Biological
(10-1-74 through 6-30-76)

Bacteria - The recent bacterial information was presented in the WATER ANALYSIS section. This included both fecal coliform and total coliform counts. The logarithmic mean of the fecal coliform bacteria was a very low 1.2 organisms/100 ml. The mean total coliform bacterial count for this segment was 2230 with a range of 8400 to 120 organisms/100 ml.

No other recent biological data were encountered.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - The NTMWD has conducted water quality analyses on raw water samples from Lake Lavon since 1956. Figure D10 presents trends in Lake Lavon water quality for the parameters chloride, total alkalinity, and total hardness. All three parameters, as well as many of the other parameters measured, show little change with time.

Tributary Water Analyses - The NTMWD has made data available concerning historical trends in water quality of three tributaries of Lake Lavon. Water from Elm Creek was analyzed between March 1960 and December 1971. The period of analysis for Ticky Creek was between February 1966 and September 1972, and Wilson Creek was analyzed between March 1960 and December 1972.

The chemical quality of the water from the three tributaries varied at certain times, but over the periods of analysis remained essentially static. The biochemical oxygen demand was the parameter which fluxuated the greatest amount. The range on the Elm Creek was from 2 to 45 mg/l,

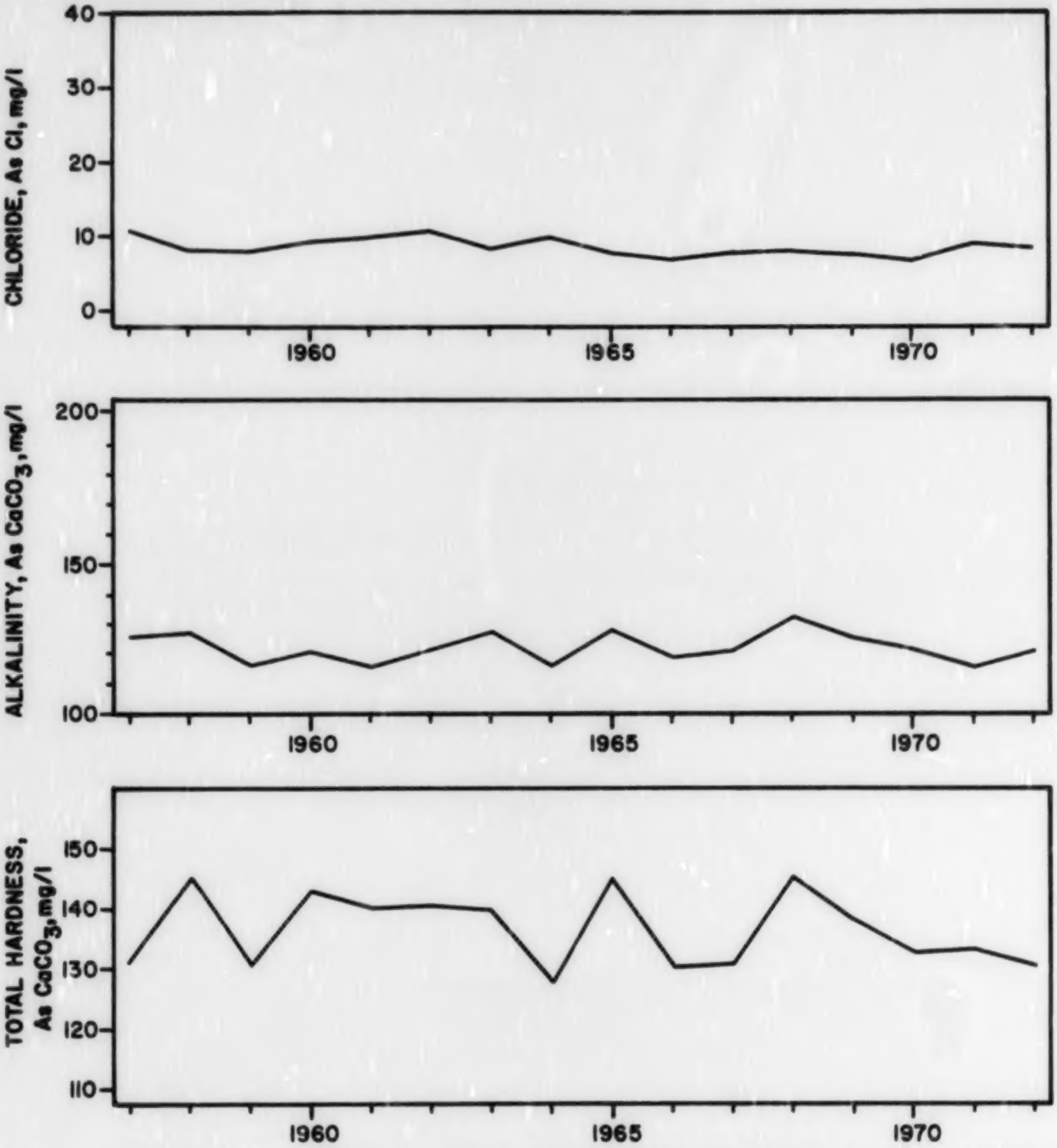


FIGURE D10. HISTORICAL DATA TRENDS FOR CHLORIDE, TOTAL ALKALINITY, AND TOTAL HARDNESS FOR LAKE LAVON (SEGMENT 0821). VALUES PLOTTED ARE YEARLY MEANS.

(DATA FROM NTMWD 1957-1972)

Ticky Creek from 1 to 20 mg/l, and Wilson Creek from 3 to 77 mg/l. Periodic high values were the case, however, and no increasing or decreasing trends could be discerned.

Sediment Analyses - TWQB (1974b) reports the following sediment pollutant concentrations for Lake Lavon. All concentrations are mg/kg, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Chemical Oxygen Demand	33030	34620	31240	-	3
Kjeldahl Nitrogen	1180	1310	1100	-	3
Oil and Grease	210	280	120	-	3
Total Phosphate	1900	2100	1700	-	3
Volatile Solids (%)	9.7	10.6	8.7	-	3
Aldrin (ug/kg)	0.0	0.0	0.0	-	3
Chlordane (ug/kg)	0.0	0.0	0.0	-	3
DDD (ug/kg)	0.3	0.4	0.2	-	3
DDE (ug/kg)	0.7	0.9	0.4	-	3
DDT (ug/kg)	0.2	0.2	0.2	-	3
Diazinon (ug/kg)	0.0	0.0	0.0	-	3
Dieldrin (ug/kg)	0.0	0.0	0.0	-	3
Endrin (ug/kg)	0.0	0.0	0.0	-	3
Heptachlor (ug/kg)	0.0	0.0	0.0	-	3
Heptachlor Epoxide (ug/kg)	0.0	0.0	0.0	-	3
Lindane (ug/kg)	0.0	0.0	0.0	-	3
Methoxychlor (ug/kg)	0.0	0.0	0.0	-	3
Methyl Parathion (ug/kg)	0.0	0.0	0.0	-	3
Parathion (ug/kg)	0.0	0.0	0.0	-	3
Silvex (ug/kg)	0.0	0.0	0.0	-	3
Toxaphene (ug/kg)	0.0	0.0	0.0	-	3
PCB (ug/kg)	0.0	0.0	0.0	-	3
Arsenic, as As	< 6.9	10.6	< 5.0	-	3
Cadmium, as Cd	< 1.0	< 1.0	< 1.0	-	3
Copper, as Cu	14.0	16.0	12.0	-	3
Chromium, as Cr	37.0	41.0	34.0	-	3
Lead, as Pb	17.0	19.0	15.0	-	3
Manganese, as Mn	470	520	390	-	3
Mercury, as Hg	0.03	0.04	0.03	-	3
Nickel, as Ni	27.0	29.0	26.0	-	3
Silver, as Ag	1.0	1.0	1.0	-	3
Zinc, as Zn	77.0	84.0	73.0	-	3

-Standard deviation not computed when N is less than six.

Biological
(Prior to 10-1-74)

Bacteria - Insufficient data exist for any analysis of trends in fecal coliform bacteria in Lake Lavon. No problem appears to exist, however, as the maximum reported fecal coliform concentration was 40 organisms/100 ml. No historical data on total coliform or other bacterial groups were encountered.

Plankton - The NTMWD has conducted phytoplankton generic identifications on raw water samples since January 1973. Most abundant genera are enumerated, with special consideration given to algae responsible for taste and odor problems. The most predominant algal genera have included *Oscillatoria*, *Anabaena*, *Melosira*, *Cyclotella*, *Chlorella*, and *Navicula*. A *Melosira* "bloom" of 4050 cells/ml occurred during March 1963. Since then, *Cyclotella* blooms have been more pronounced, with concentrations in excess of 5000 cells/ml occurring on dates in February 1965, May 1966, and January 1969. Blue-green algae, such as *Oscillatoria* sp. and *Anabaena* sp., seldom reach concentrations as high as 1000 cells/ml. In general, the concentrations of the most abundant genera are usually around 200 cells/ ml.

No other historical biological data were encountered for Lake Lavon.

NONPOINT VS. POINT SOURCE LOADINGS

According to EPA (1976a), the annual total nitrogen and total phosphorus loadings to Lake Lavon are 8.711 x 10^5 kilograms per year and 8.871 x 10^4 kilograms per year respectively. The East Fork of the Trinity River was reported to contribute 31.5% of the total nitrogen and 32.8% of the total phosphorus load to Lake Lavon. Local point source discharges (12) contribute 6.84% of the total nitrogen load and 30.7% of the total phosphorus load to the reservoir. Net annual accumulations of total nitrogen and total phosphorus in Lake Lavon, as reported by EPA (1976a), are 4.758 x 10^5 kilograms and 6.871 x 10^4 kilograms respectively.

WATER USES

Domestic and Municipal

Lake Lavon is very heavily used as a source of domestic and municipal water. The primary user is the NTMWD. Water rights permits for domestic and municipal withdrawals from this segment total 1.2 x 10^8 cubic meters per year (95,500 acre-feet per year). The estimated yield for this segment under year 2000 conditions, according to NCTCOG (1974), will be 4.1 cubic meters per second (92.9 MGD).

Industrial

Lake Lavon is moderately used as an industrial water supply. The sole user is Garland Municipal Power and Light Company. Water rights permits for industrial withdrawal from this segment total 9.9 x 10^5 cubic meters per year (8,000 acre-feet per year). According to NCTCOG (1974), the water is used for cooling electrical generator steam condensing towers, and in doing so 1.8 x 10^3 cubic meters per second (0.04 MGD) are consumed by evaporation. In addition, some of the water removed for domestic and municipal use may be consumed by local industry.

Agricultural

Lake Lavon is slightly used as a source of agricultural water. The holder of the water rights permit, which is for 6.16 x 10^5 cubic meters (500 acre-feet) per year, is the North Texas Municipal Water District.

Recreational

Lake Lavon is heavily used for recreation. Activities on the lake include motorboating, sailing, swimming, water skiing, and fishing.

SUMMARY

Water quality in Lake Lavon is good with a few exceptions. All TWQB (1976a) criteria were met. However, the lake has fairly high nutrient concentrations and turbidity levels. Stratification has not been as pronounced in Lake Lavon as in other area lakes, due to its recent relative shallowness.

Numerous tributaries to Lake Lavon carry sewage effluent affecting the water quality of the lake. Nutrients from this input sustain periodic high phytoplankton levels.

Historical data indicate a relative consistency in water quality over the years. Historical biological data, other than those for phytoplankton, were virutally absent.

ADDITIONAL DATA NEEDS

The available data on Lake Lavon are sufficient for analysis of historical trends, and the continuation of current monitoring programs will provide sufficient data for analysis of future trends. Analyses of point *vs*. nonpoint source loadings will require additional data. The data required will be of the type now being collected on Lake Ray Hubbard by the City of Dallas and the University of Texas at Dallas as part of the 208 planning project of the North Central Texas Council of Governments. The data required for Lake Lavon could most efficiently be determined when the results of the Lake Ray Hubbard study are available.

The available data on Lake Ray Hubbard are sufficient to indicate some trends, and current monitoring programs, if maintained, would suffice to determine future trends. The current study of the lake will provide a comprehensive analysis of nonpoint *vs*. point source loadings and will determine any future data needs for such analysis.

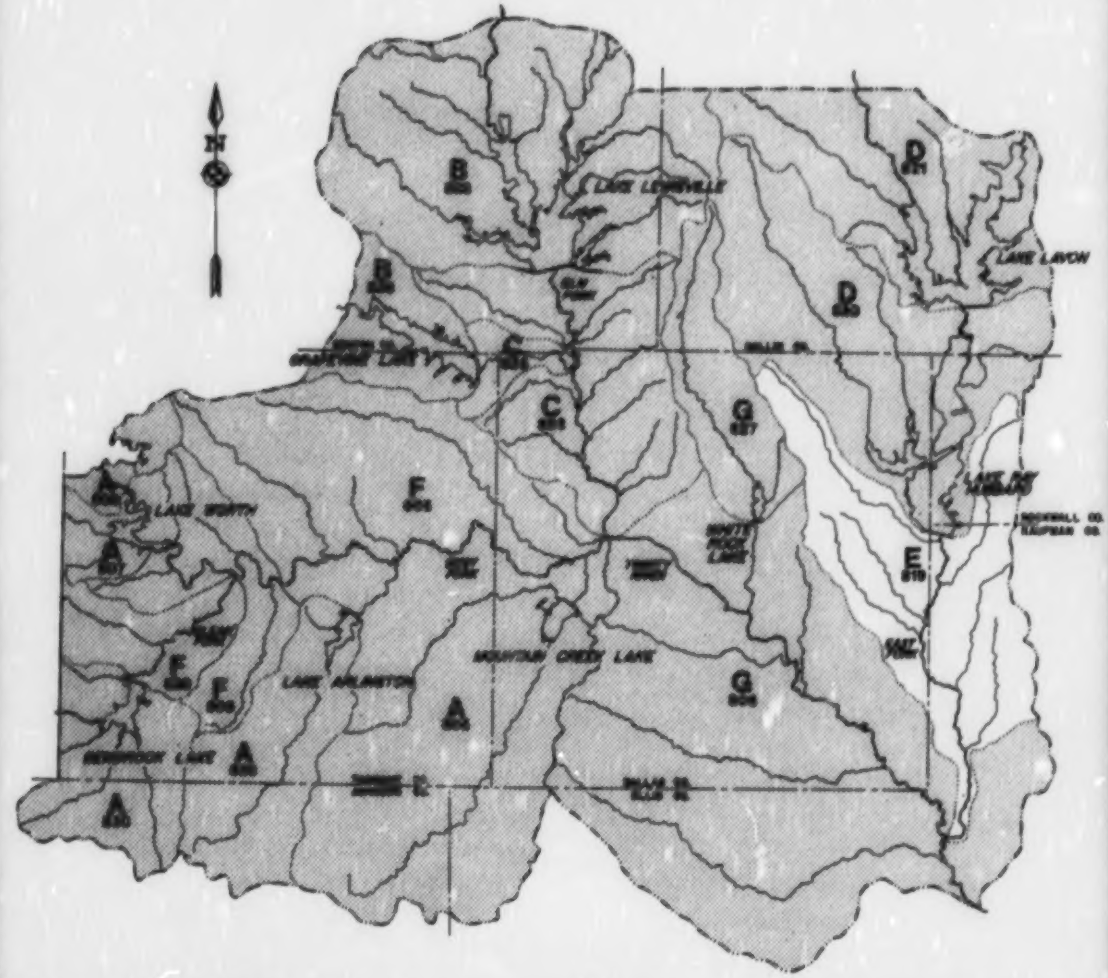
Unfortunately, few data exist concerning the fishes or macrophytes of both Lake Lavon and Lake Ray Hubbard. Data such as these need to be generated in order to make a more complete and comprehensive assessment of the lake's overall quality.

PRESENTATION AREA E

EAST FORK BELOW LAKES

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B
LAKE LEWISVILLE
D
LAKE LAVON
B
D
GRAPEVINE LAKE
C
C
G
F
A
LAKE WORTH
A
LAKE RAY HUBBARD
ROCKWALL CO.
KAUFMAN CO.
WHITE ROCK LAKE
E
MOUNTAIN CREEK LAKE
F
F
LAKE ARLINGTON
A
G
BENBROOK LAKE
A
A

PRESENTATION AREA E - EAST FORK BELOW LAKES

SUMMARY

The East Fork of the Trinity River receives wastewater from six municipal sewage treatment plants. Consequently, water in the East Fork is largely dominated by sewage. Dissolved oxygen and fecal coliform both pose substantial problems in the East Fork. Many times the dissolved oxygen concentration fell below the TWQB (1976a) standard of 2.0 mg/l, and several values of 0.0 mg/l were reported. Similarly, the logarithmic mean fecal coliform concentration, 47000 organisms/100 ml, was greatly in excess of the standard of 2000 organisms/100 ml.

Other parameters, such as ammonia, phosphate, chlorophyll a, and biochemical oxygen demand also are very high in concentration in the East Fork compared to similar bodies of water in the Dallas-Fort Worth 208 area. All of this also results from the high effluent load carried by the East Fork.

From an analysis of the tributaries entering the East Fork, it can be determined that Duck Creek provides water with the greatest amount of nutrient and oxygen-demanding material. Sediment analyses are insufficient for stating anything conclusive, although they appear to be laden with large amounts of nitrogen, phosphorus, oil and grease, and several heavy metals.

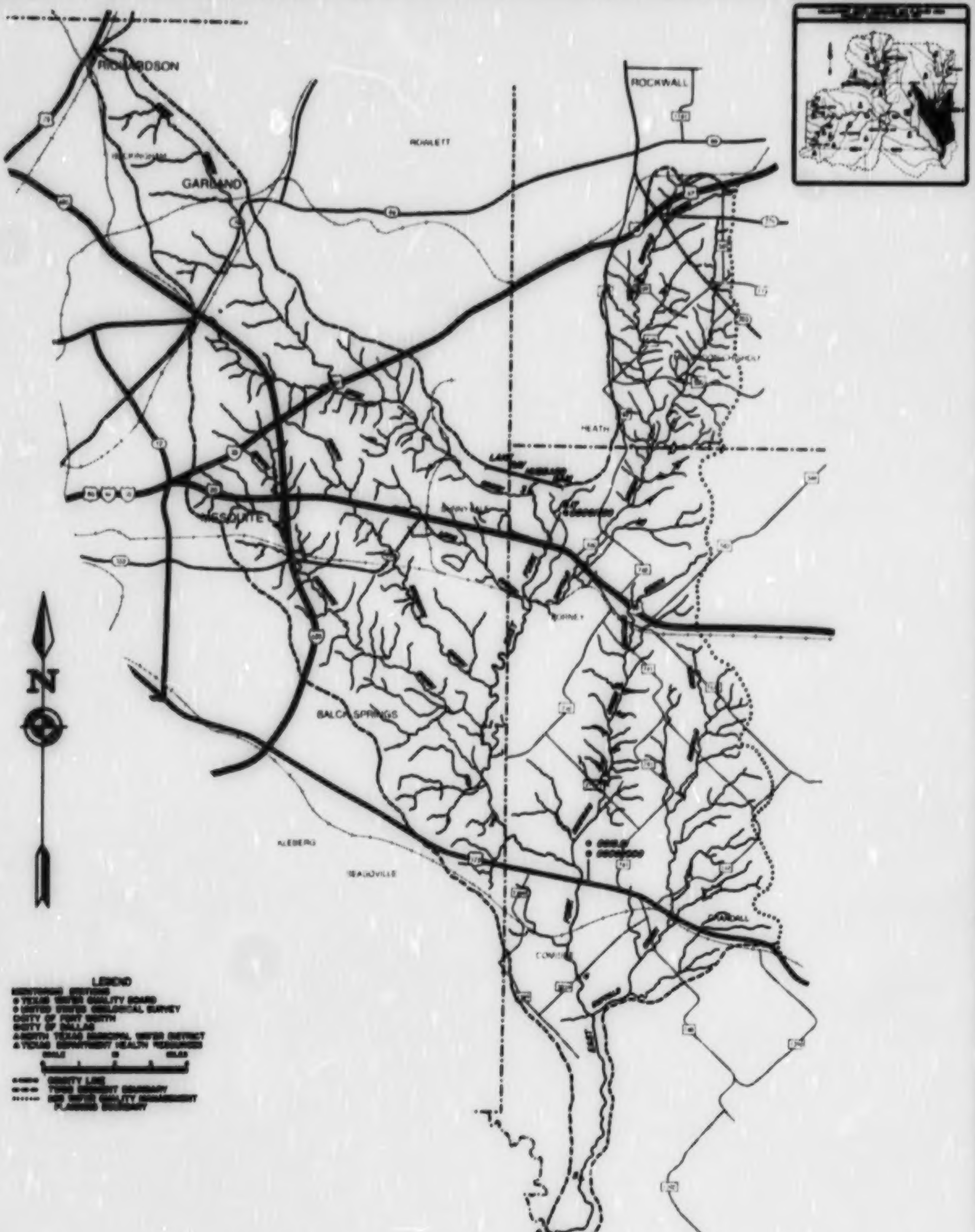
Biological data, other than bacteriological analyses, are almost entirely lacking for the East Fork. While this may also be virtually true for aquatic life in the East Fork, surveys of the extant biota should be encouraged.

Figure E1 shows an enlarged map of Segment 0819, pinpointing existing monitoring stations.

MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Segment 0819			
DAL	East Fork at I-20	17	
NT	East Fork above S. Mesquite Creek	1	C
NT	East Fork at Malloy Bridge Road	2	C
NT	East Fork above Duck Creek	3	C
NT	East Fork at FM 3039	4	C
NT	East Fork near confluence with Trinity River	5	C
TWQB	East Fork at US 175 near Crandall	0819.01	CbBcMbS
USGS	East Fork near Forney	08061750	Dd
USGS	East Fork near Crandall	08062000	DdQOp

*The "Type of Record" designations for each Agency are explained under Appendix A, Sources of Information.


RICHARDSON
ROCKWALL
ROWLETT
GARLAND
HEATH
LAKE RAY HUBBARD
MESQUITE
FORNEY
BALCH SPRINGS
KLEBERG
SEAGOVILLE
CRANDALL
COMBINE
EAST FORK
N
LEGEND
MONITORING STATIONS
TEXAS WATER QUALITY BOARD
UNITED STATES GEOLOGICAL SURVEY
CITY OF FORT WORTH
CITY OF DALLAS
NORTH TEXAS MUNICIPAL WATER DISTRICT
TEXAS DEPARTMENT HEALTH RESOURCES
SCALE 0 MILES
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY

PRESENTATION AREA E - Segment 0819

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE E1

EAST FORK TRINITY RIVER BETWEEN RAY HUBBARD DAM AND CONFLUENCE WITH THE MAIN STEM TRINITY RIVER - Segment 0819

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - East Fork (DAL 17; NT 1, 2, 3, 4, 5; TRA; TWQB 0819.01; USGS 08062000). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.5	31.0	4.0	4.2	80
Dissolved Oxygen	2.1	13.0	0.0	**	82
pH (pH units)	7.4	8.3	6.8	0.2	80
Conductivity (umhos/cm)	456	693	190	88	81
Total Suspended Solids	87	555	3	**	46
Volatile Suspended Solids	39	202	1	**	44
Total Dissolved Solids	270	463	124	78	36
Ammonia, as N	7.2	22.6	0.10	**	69
Nitrite, as N	0.02	0.10	0.00	**	54
Nitrate, as N	0.12	0.58	0.00	**	55
Organic Nitrogen, as N	2.6	12	0.39	**	37
Total Phosphate, as P	4.9	11	0.23	**	37
Orthophosphate, as P	6.1	64.2	0.06	**	76
Chloride, as Cl	30	57	1.9	**	79
Sulfate, as SO_4	34	59	9.8	12	60
Total Alkalinity, as $CaCO_3$	163	264	86	42	51
Carbonate, as CO_3	0	0	0	0	21
Total Hardness, as $CaCO_3$	128	164	90	18	51
Noncarbonate Hardness, as $CaCO_3$	3	14	0	**	21
Chlorophyll *a* (ug/l)	23	49	5	**	6
Fecal Coliform (#/100 ml)	47000*	9.4x10^6	0	**	26
Total Coliform (#/100 ml)	7x10^6	4.4x10^7	1150	**	21
Color (Pt-Co units)	31	90	0	**	21
Turbidity (JTU)	31	100	6	**	40
Biochemical Oxygen Demand$_5$	24	56	2	**	56
Total Organic Carbon	21	44	4.3	**	40
Phenols (ug/l)	14.4	90	0	**	20
Methylene-Blue-Active Sub.	0.7	2.2	0.0	**	21
Silica, as SiO_2	7.0	13	0.9	3.5	21
Calcium, as Ca	46	56	36	6.9	21
Magnesium, as Mg	2.9	5.0	1.6	0.8	21
Sodium, as Na	33	72	12	**	21
Potassium, as K	6.4	12	3.2	3.0	21
Sodium Absorption Ratio, SAR	1.3	3.0	0.4	**	21
Fluoride, as F	1.1	2.9	0.3	**	18
Aluminum, as Al (ug/l)	77	120	20	-	3
Arsenic, as As (ug/l)	3	3	2	-	3
Boron, as B (ug/l)	320	340	290	-	3
Cadmium, as Cd (ug/l)	2	3	0	-	3
Chromium, as Cr (ug/l)	6	10	0	-	3

continued. . .

Parameter	Mean	Max	Min	S	N
Cobalt, as Co (ug/l)	0	0	0	-	3
Copper, as Cu (ug/l)	21	41	4	-	3
Iron, as Fe (ug/l)	170	230	120	-	3
Lead, as Pb (ug/l)	6	14	0	-	3
Lithium, as Li (ug/l)	7	10	1	-	3
Manganese, as Mn (ug/l)	107	190	60	-	3
Mercury, as Hg (ug/l)	0.3	0.6	0.0	-	3
Nickel, as Ni (ug/l)	19	28	7	-	3
Strontium, as Sr (ug/l)	620	750	550	-	3
Zinc, as Zn (ug/l)	23	50	9	-	3

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in the East Fork Trinity River were taken from TWQB (1976a).

Temperature - Not to exceed 32.8 °C. Criterion met.
Dissolved Oxygen - Criterion not met. Segment 0819 is considered an "inland effluent-dominated stream" by TWQB (1976a). The dissolved oxygen criterion for such a stream is 2.0 mg/l (minimum). The mean value of 2.1 mg/l, as recorded in the WATER ANALYSES table, indicates that much of the time dissolved oxygen concentrations were below the 2.0 mg/l standard. As a matter of fact, several values of 0.0 mg/l were reported.
pH- Acceptable range: 6.5-8.5. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 400 mg/l. Criterion met (no reported values exceeded 400 mg/l).
Chloride - Mean concentration not to exceed 75 mg/l. Criterion met (no reported values exceeded 75 mg/l).
Sulfate - Mean concentration not to exceed 50 mg/l. Criterion met (a high value of 59 mg/l was reported).
Fecal Coliform - Log. mean not to exceed 2000 organisms/100 ml. Criterion not met. Available recent data produce a log. mean fecal coliform concentration of 47,000 organisms/100 ml. This is nowhere close to the standard of 2000 organisms/100 ml. Poorly treated municipal sewage entering the East Fork, primarily from Duck Creek, has resulted in fecal coliform problems for a long time.

As stated in TWQB (1976a), fecal coliform data must be "from a representative sampling of not less than 5 samples collected over not more than 30 days." The NTMWD collected and analyzed a large number of samples from the lower East Fork over a two-week period. The log. mean fecal coliform count from this sampling was in excess of 400,000 organisms/100 ml.

Much of the difference between high and low values of the various water quality parameters could be attributed to the high variability of flows during the period. Flows ranged from a high of 399 cubic meters per second (14,100 cfs) to a low of 0.9 cubic meters per second (33 cfs). The high flows helped account for the low nutrient concentrations and high suspended solids values reported. High dissolved oxygen values reported came exclusively from a station upstream from Duck Creek.

The mean orthophosphate concentration exceeded the mean total phosphate concentration, due primarily to the fact that additional data points were available for orthophosphate. Several of these were extremely high (e.g. 64.2 mg/l).

Chlorophyll a values were relatively high, with data producing a maximum concentration of 49 ug/l. This is due largely to the abundance of nutrients in the East Fork and the subsequent effect of these nutrients upon the phytoplankton community. BOD values were high, also being connected with the effluent in the river.

Tributary Water Analyses - Tributaries joining the East Fork between Ray Hubbard Dam and the confluence with the main stem include Buffalo Creek (south of FM 3039), Mustang Creek, Buffalo Creek (south of US 80), Duck Creek, Long Creek, North Mesquite Creek, and South Mesquite Creek. Two of these creeks, Duck Creek and South Mesquite Creek, carry substantial loads of poorly treated sewage effluent, greatly affecting water quality in the East Fork below Duck Creek. The impact of these two creeks can be noted in Figure E2, which shows profiles with river mile for the East Fork. Figure E2 presents river mile trends for the parameters dissolved oxygen, ammonia, and fecal coliform. Depressed dissolved oxygen levels occur immediately below the Duck Creek confluence, with values of 0.0 mg/l reported for 12 miles downstream. A gradual recovery takes place, with the mean dissolved oxygen level reaching about 5.0 mg/l at the main stem confluence. Similar trends occur for ammonia and fecal coliform, as well as other effluent-associated parameters, such as biochemical oxygen demand and phosphate.

Recent data for Duck Creek and South Mesquite Creek exist for a number of parameters. The following tables summarize available data on Duck Creek and South Mesquite Creek. Concentrations are in mg/l, unless otherwise specified.

Water Quality of
Duck Creek Above Duck Creek STP
(Data From NTMWD 1975-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	8	8	7	0.4	8
Dissolved Oxygen	10.5	12.8	7.2	2.0	8
pH (pH units)	7.65	7.78	7.58	0.07	8
Conductivity (umhos/cm)	394	480	360	42	8
Turbidity (NTU)	32	32	32	-	1
Biochemical Oxygen Demand$_5$	6	6	6	-	1
Biochemical Oxygen Demand$_{20}$	18	18	18	-	1
Biochemical Oxygen Demand$_{20n}$	14	14	14	-	1

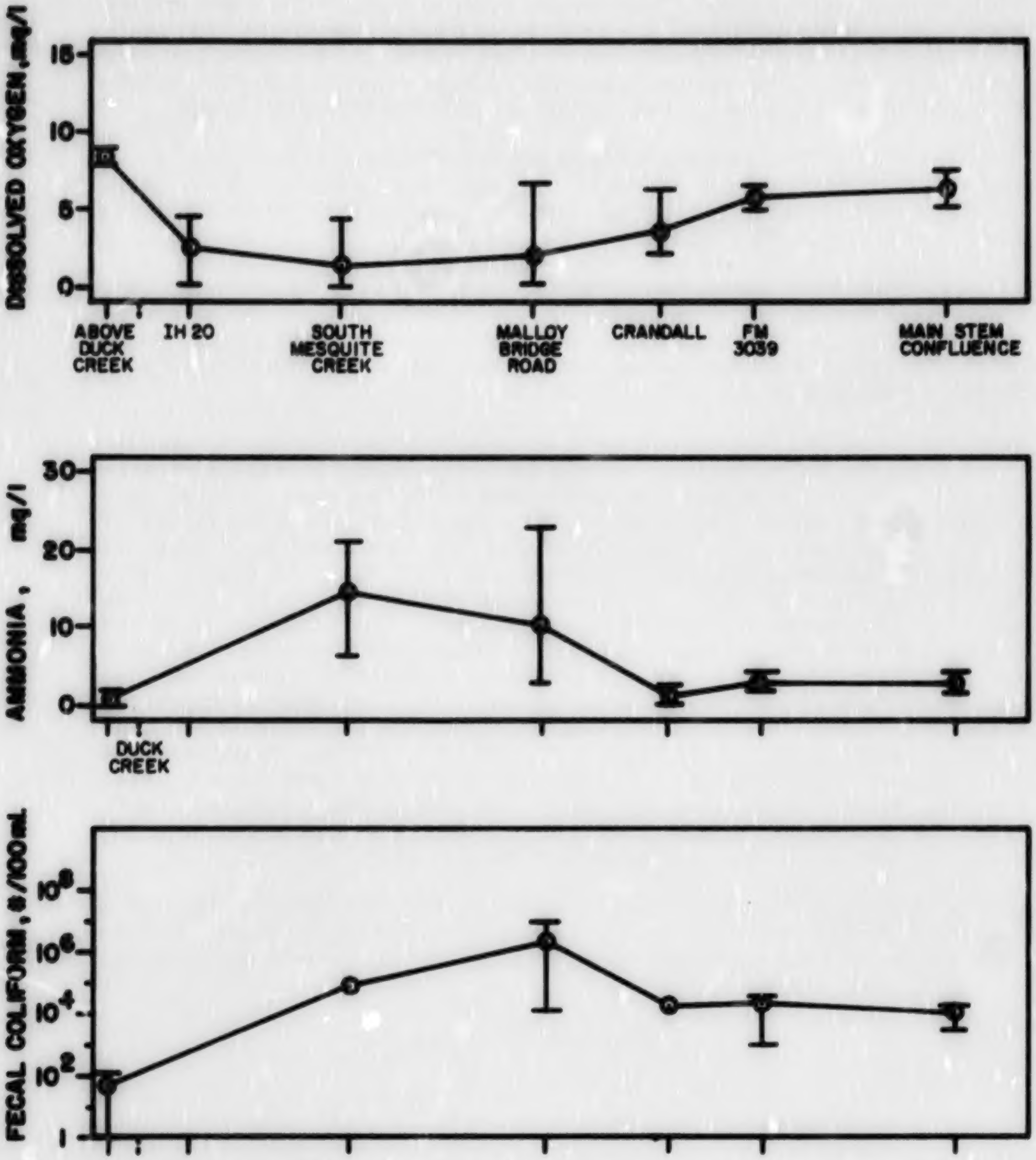


FIGURE E2. EAST FORK (Segment 0819) PROFILES FOR DISSOLVED OXYGEN, AMMONIA, AND FECAL COLIFORM.
VALUES PLOTTED ARE MEANS AND RANGES, AND THE PERIOD COVERED IS FROM 4-1-76 THROUGH 6-30-76.
(DATA FROM CITY OF DALLAS, NTMWD, TWQB, USGS)

continued. . .

Parameter	Mean	Max	Min	S	N
Total Solids	418	418	418	-	1
Total Suspended Solids	37	37	37	-	1
Total Dissolved Solids	381	381	381	-	1
Ammonia, as N	0.50	0.50	0.50	-	1
Nitrite, as N	0.00	0.00	0.00	-	1
Nitrate, as N	0.085	0.085	0.085	-	1
Organic Nitrogen, as N	0.19	0.19	0.19	-	1
Total Phosphate, as P	0.40	0.40	0.40	-	1
Fecal Coliform (#/100 ml)	2875	6500	0	-	4

-Standard deviation not computed when N is less than six.
n nitrogen-inhibited.

Water Quality of
Duck Creek Below Duck Creek STP
(Data From NTMWD 1975-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	14	15	13	0.7	8
Dissolved Oxygen	0.8	1.0	0.6	0.1	8
pH (pH units)	7.29	7.36	7.22	0.05	8
Conductivity (umhos/cm)	416	520	380	44	8
Turbidity (NTU)	80	80	80	-	1
Biochemical Oxygen Demand$_5$	59	59	59	-	1
Biochemical Oxygen Demand$_{20}$	116	116	116	-	1
Biochemical Oxygen Demand$_{20n}$	84	84	84	-	1
Total Solids	414	414	414	-	1
Total Suspended Solids	47	47	47	-	1
Total Dissolved Solids	367	367	367	-	1
Ammonia, as N	11.75	11.75	11.75	-	1
Nitrite, as N	0.004	0.004	0.004	-	1
Nitrate, as N	0.131	0.131	0.131	-	1
Organic Nitrogen, as N	4.51	4.51	4.51	-	1
Total Phosphate, as P	9.17	9.17	9.17	-	1
Fecal Coliform (#/100 ml)	1.4x10^6	1.8x10^6	1.1x10^6	-	4

-Standard deviation not computed when N is less than six.
n nitrogen-inhibited.

Water Quality of
South Mesquite Creek Below Mesquite STP
(Data From NTMWD 1975-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	12	14	11	0.9	8
Dissolved Oxygen	5.4	6.4	3.8	0.8	8
pH (pH units)	7.34	7.44	7.28	0.06	8

continued. . .

Parameter	Mean	Max	Min	S	N
Conductivity (umhos/cm)	446	524	410	39	8
Turbidity (NTU)	54	54	54	-	1
Biochemical Oxygen Demand$_5$	23	23	23	-	1
Biochemical Oxygen Demand$_{20}$	114	114	114	-	1
Biochemical Oxygen Demand$_{20n}$	56	56	56	-	1
Total Solids	410	410	410	-	1
Total Dissolved Solids	54	54	54	-	1
Total Suspended Solids	356	356	356	-	1
Ammonia, as N	25.0	25.0	25.0	-	1
Nitrite, as N	0.008	0.008	0.008	-	1
Nitrate, as N	0.077	0.077	0.077	-	1
Organic Nitrogen, as N	12.56	12.56	12.56	-	1
Total Phosphate, as P	12.84	12.84	12.84	-	1
Fecal Coliform (#/100 ml)	4.4×10^5	5.5×10^5	3.7×10^5	-	4

-Standard deviation not computed when N is less than six.
n nitrogen-inhibited.

Sediment Analyses - The following table summarizes recent sediment analyses conducted on the lower East Fork. Data are from Ecosystems Management (1976) and TWQB (1975-1976) (TWQB 0819.01). All concentrations are in mg/kg, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Total Kjeldahl Nitrogen	1045	1258	916	-	4
Organic Nitrogen	2015	2015	2015	-	1
Oil and Grease	579	1889	21	-	5
Phosphorus in Particulates	500	500	500	-	1
Arsenic, as As	8.44	15.40	0.58	-	5
Barium, as Ba	126.8	126.8	126.8	-	1
Boron, as B	24.4	24.4	24.4	-	1
Cadmium, as Cd	4.18	6.55	2.95	-	5
Chromium, as Cr	< 8.0	20.1	< 5.0	-	5
Copper, as Cu	57.6	105.0	39.1	-	5
Lead, as Pb	29.0	64.8	9.0	-	5
Manganese, as Mn	339.4	452.2	133.9	-	5
Mercury, as Hg	0.020	0.033	0.003	-	4
Nickel, as Ni	63.1	92.0	13.0	-	5
Selenium, as Se	0.09	0.09	0.09	-	1
Silver, as Ag	1.6	1.6	1.6	-	1
Zinc, as Zn	90.8	104.9	70.6	-	5
DDT (ug/kg)	6440	21600	0	-	4
Dieldrin (ug/kg)	4.3	7.7	0.0	-	4
Endrin (ug/kg)	16.4	53.0	0.0	-	4
Heptachlor (ug/kg)	2	7	0	-	4
Lindane (ug/kg)	0	0	0	-	4

-Standard deviation not computed when N is less than six.

The East Fork sediments appear to be heavily laden with numerous materials, particularly organic nitrogen, phosphorus, and oil and grease. This would be attributable to the treated sewage effluents entering upstream from this TWQB sediment sampling station. Since only one to six data points per parameter exist for the recent period, no definite conclusions may be drawn.

Biological
(10-1-74 through 6-30-76)

Bacteria - Recent bacteria data for the East Fork were summarized in the WATER ANALYSES section. Reported data showed a maximum fecal coliform count of 9,400,000 organisms/100 ml and a logarithmic mean count of 47,000 organisms/100 ml. This mean is well above the standard of 2000 organisms/ 100 ml. It is apparent that the East Fork has a considerable bacteria problem, resulting from the inadequately treated sewage entering the river primarily from Duck Creek.

The mean total coliform count was 7,000,000 organisms/100 ml, and the maximum reported was 44,000,000 organisms/100 ml. Non-fecal coliform bacteria may be found in soil, on plants and insects, and in "old" sewage.

No data on fecal streptococcus or other bacteria were encountered.

Plankton - No recent phytoplankton counts or identifications were encountered for the East Fork. One would expect to find relatively high concentrations of phytoplankton, due to the overabundance of nutrients. This is supported by a mean chlorophyll a concentration of 23 ug/l, indicating that eutrophic conditions exist in the East Fork. One also would expect to find relatively high proportions of the genera *Euglena*, *Phacus*, *Chlorella*, *Scenedesmus*, *Chlamydomonas*, *Nitzschia*, *Microcystis*, *Gomphonema*, and *Aphanizomenon* present, as these organisms have shown a preference for ammonia as a primary source of nutrition and are indicators of gross organic pollution.

No other recent biological data were encountered for the lower East Fork.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Historical trends are presented for flow, pH, dissolved oxygen, total dissolved solids, ammonia, nitrite and nitrate, total phosphorus, chloride, and sulfate in Figures E3 and E4 for the period 1968-1975. Most of the parameters appear to show a strong inverse relationship with the flow. However, the high variations in flow over this period make trend analysis difficult. One parameter not directly affected by flow variation, pH, shows no increasing or decreasing trend over this period.

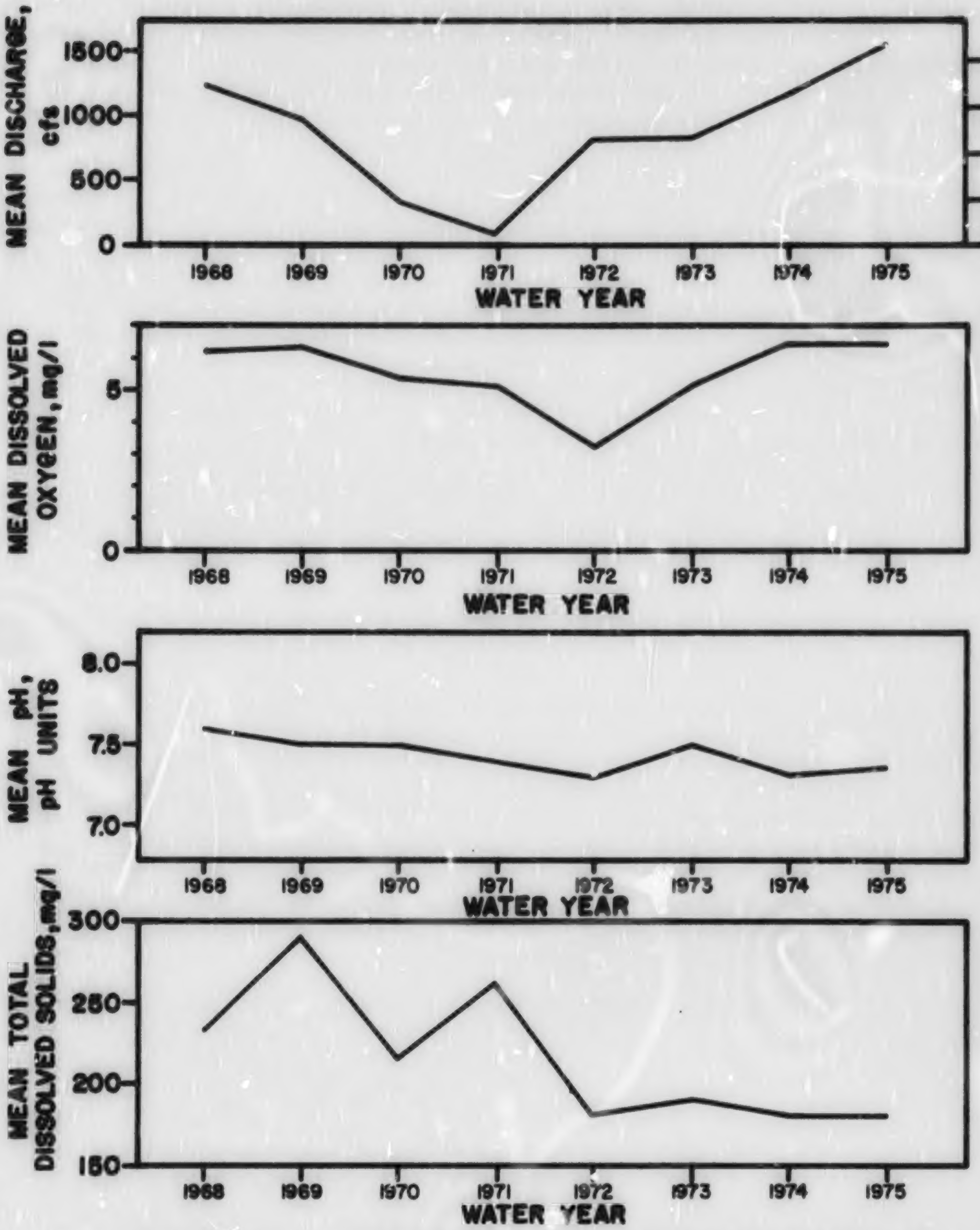


FIGURE E3. HISTORICAL DATA TRENDS EXHIBITED BY DISCHARGE, DISSOLVED OXYGEN, pH, AND TOTAL DISSOLVED SOLIDS FOR THE LOWER EAST FORK (Segment 0819). (DATA FROM USGS 1968-1975)

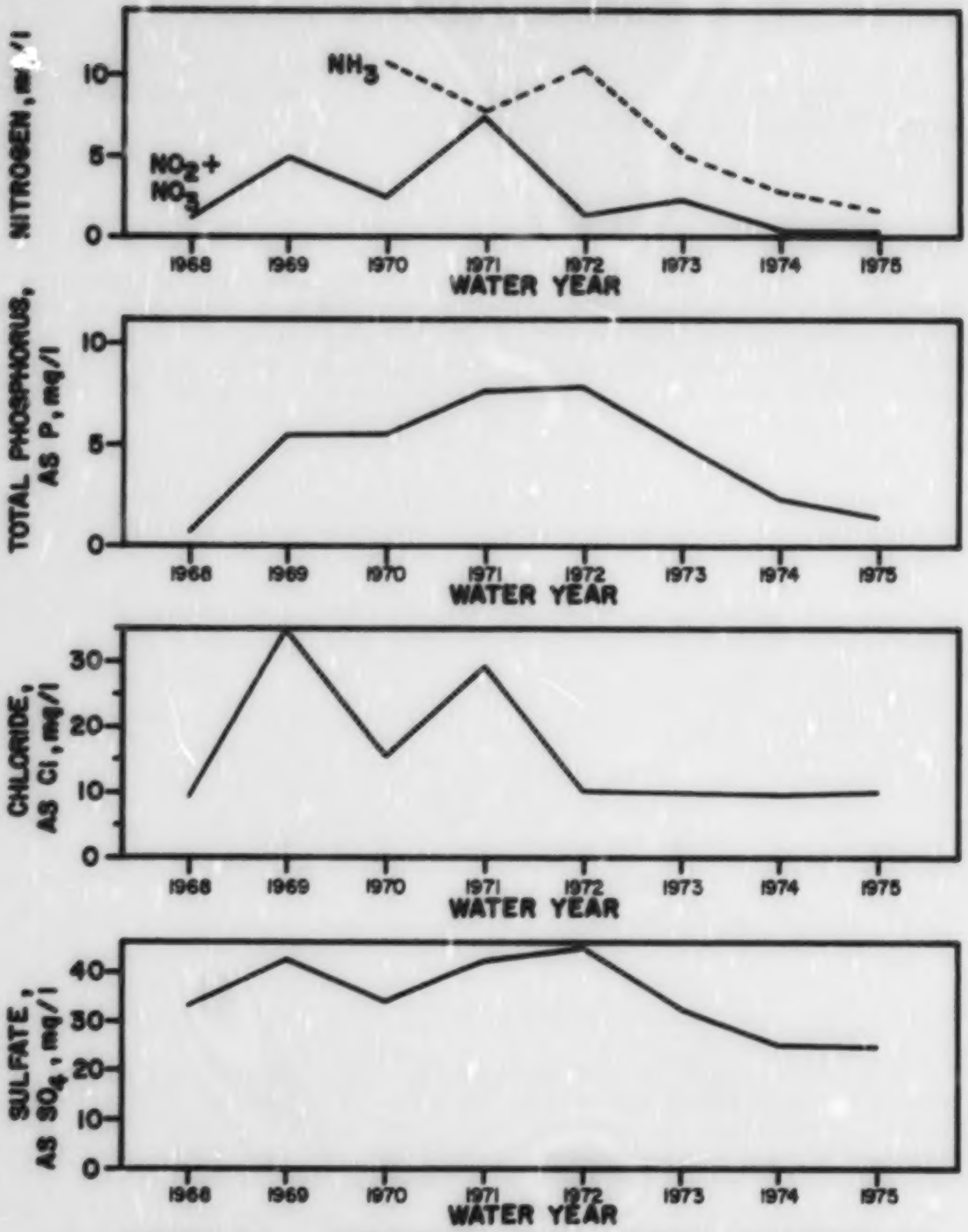


FIGURE E4. HISTORICAL DATA TRENDS EXHIBITED BY AMMONIA, NITRITE + NITRATE, TOTAL PHOSPHATE, CHLORIDE, AND SULFATE FOR THE LOWER EAST FORK (Segment 0819).
(DATA FROM USGS 1968-1975)

Tributary Water Analyses - Insufficient data were available for trend analyses of tributaries entering the East Fork.

Sediment Analyses - Insufficient data were encountered to analyze trends in contaminants in bottom sediments.

Biological
(Prior to 10-1-74)

Bacteria - Insufficient data have been reported to develop trends for bacteria in the East Fork. However, TWQB (1972-1976) has reported values for fecal coliform as high as 240,000 organisms/100 ml in WY 1972. This is not too high compared to the recent period high of 1,940,000 organisms/100 ml. Again, insufficient data exist to be able to say whether values are increasing or decreasing.

Plankton - No historical phytoplankton or zooplankton data were encountered for the East Fork Trinity River.

Aquatic Vegetation - No historical data regarding vegetation present in the East Fork were encountered.

Macroinvertebrates - No macroinvertebrate data were encountered.

Fishes - Table XXI presents fish species reported by Fullwood (1950) for the East Fork. The gizzard shad (Dorosoma cepedianum) was by far the most common species reported. No parasitic copepoda were encountered on any of the fish collected.

NONPOINT VS. POINT SOURCE LOADINGS

The lower East Fork, extending from Lake Ray Hubbard Dam to the Trinity River confluence, is approximately 48 kilometers (30 miles) in length. Releases from Lake Ray Hubbard are joined by flows from tributaries such as Duck Creek, Long Creek, Buffalo Creek, North and South Mesquite Creeks, Mustang Creek, and several unnamed creeks. The total drainage area of the East Fork is about 629 square kilometers (243 square miles) and includes several cities, such as Seagoville, Crandall, Rockwall, Heath, Forney, Mesquite, and Garland.

Streamflow is largely regulated by releases from Lake Ray Hubbard. Available data from the Crandall station (USGS 08062000) during the period 1970 to 1975 revealed that streamflow varied from less than 0.85 cubic meters per second (30 cfs) to more than 420 cubic meters per second (15,000 cfs). Under low flow conditions, flow in the East Fork is virtually all sewage effluent from Duck Creek, Forney, Crandall,

TABLE NO. XXI

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR EAST FORK TRINITY RIVER (SEGMENT 0819)

(Taken from Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	25	1¼"-2"
Notropis lutrensis Plains red shiner	27	2¼"-2½"
Ceratichthys vigilax (*Pimephales vigilax* (Baird & Girard)) Bullnose minnow (Bullhead minnow)	17	2"-3"
Opsopoeodus emiliae Pugnose minnow	10	1¼"-1½"
Campostoma anomalum Stoneroller	22	2"-3¼"
Notemigonus crysoleucas Golden shiner	14	1½"-2½"
Gambusia affinis Mosquitofish	34	1½"-2"
Lepomis macrochirus Bluegill	12	2"-4"
Pomoxis annularis White crappie	18	2½"-3½"
Huro salmoides (*Micropterus salmoides* (Lacepede)) Black bass (Largemouth bass)	9	½"-2¼"
Dorosoma cepedianum Gizzard shad	67	3½"-5½"
Hydropterus scierus (*Percina scierus* (Swain)) Dusky darter	11	2¼"-3¼"

continued. . .

Species	Number Captured	Size Range
Megastomatobus cyprinella (*Ictiobus cyprinellus* (Valenciennes)) Big mouth buffalo (Largemouth buffalofish)	19	2"-3¼"
Cyprinus carpio Carp	10	1½"-2¼"
Ictalurus lacustris (*Ictalurus punctatus* (Rafinesque)) Southern channel catfish	9	2½"-5½"
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) Black bullhead	17	2"-3½"
Ameiurus natalis (*Ictalurus natalis* (Lesueur)) Yellow bullhead	8	1½"-2"
Schilbeodes nocturnus (*Nocturus nocturnus* (Jordan & Gilbert)) Freckled madtom	5	1¼"-1½"
TOTAL	334	

No parasitic Copepoda were observed in or on the fish collected.

Seagoville, and Mesquite STP's. The quality characteristics of this streamflow are consistently high nutrient concentrations and low dissolved oxygen levels.

During high flow conditions, reservoir releases and runoff contributions from rural and suburban watersheds not only add streamflow, but also influence water quality in the East Fork. Figure E5 shows phosphorus concentration versus streamflow at the Crandall station on the East Fork. In this fugure, the phosphorus concentration reveals a pronounced inverse relation with streamflow (i.e. the higher the streamflow, the lower the level of phosphorus, and vice versa).

The specific conductance, being related to the number and type of ions in solution, can be used for approximating the inorganic chemical quality of the water. Figure E6 presents specific conductance versus streamflow at the Crandall station (USGS 08062000). In this figure, the higher conductivity is associated with the lower streamflow. However, the conductivity seems to level off at about 300 micromhos/cm at flows in excess of 28.3 cubic meters per second (1000 cfs). In general, it can be stated that relatively lower streamflow means poorer inorganic chemical quality. However, if the streamflow exceeds 28.3 cubic meters per second (1000 cfs), the chemical quality appears to be independent of the streamflow.

The expansion of Dallas-Fort Worth metroplex area has stimulated the growth of watersheds in this segment of the river. The dense population areas, such as Garland and Mesquite, have generated wastewater in excess of their designed capacity for sewage treatment. As the result of these overloads, the plants consistently produce poor quality effluents. Some of the less populated areas are currently served by septic tanks. Currently, there are no available data for assessing nonpoint source pollution in this segment. However, according to TWQB (1975-1976), there are no industrial and five domestic point sources with flows in excess of 0.002 cubic meters per second within the lower East Fork drainage area.

WATER USES

Domestic and Municipal

The East Fork Trinity River between Lake Ray Hubbard and the main stem is not used as a source of domestic and municipal water.

Industrial

There are no permits issued authorizing the removal of water from the East Fork for industrial purposes.

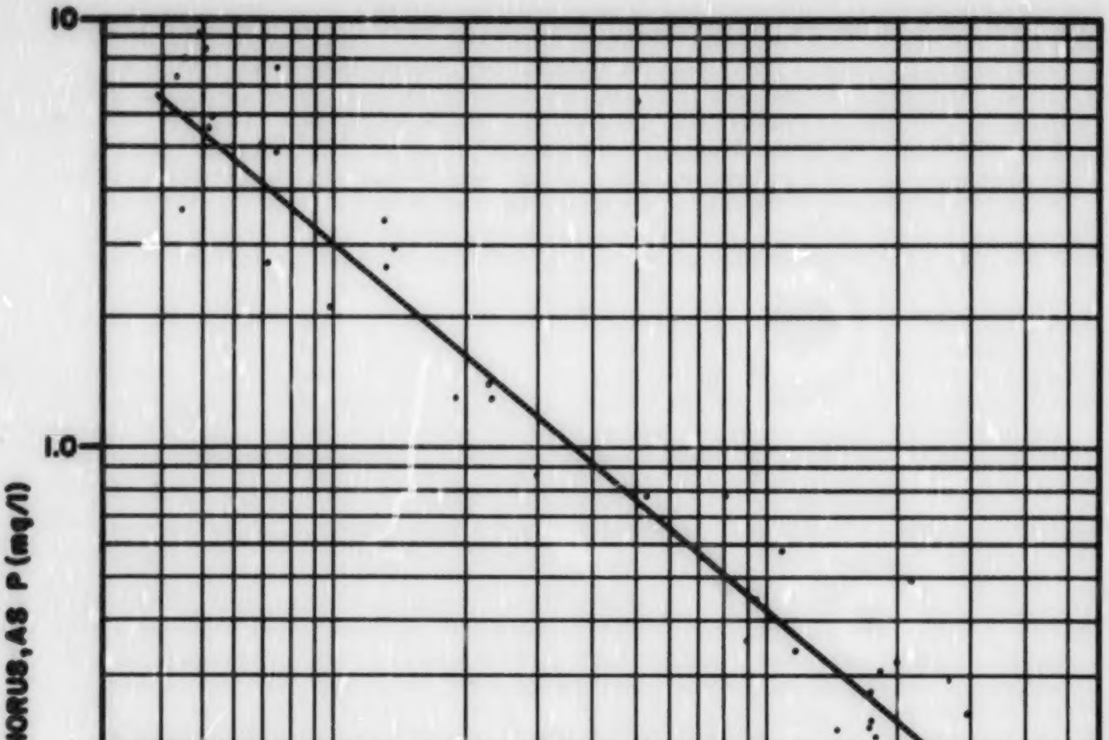


FIGURE E5. TOTAL PHOSPHORUS CONCENTRATION vs. STREAMFLOW AT US 175 NEAR CRANDALL.
(DATA FROM USGS 1972-1975)

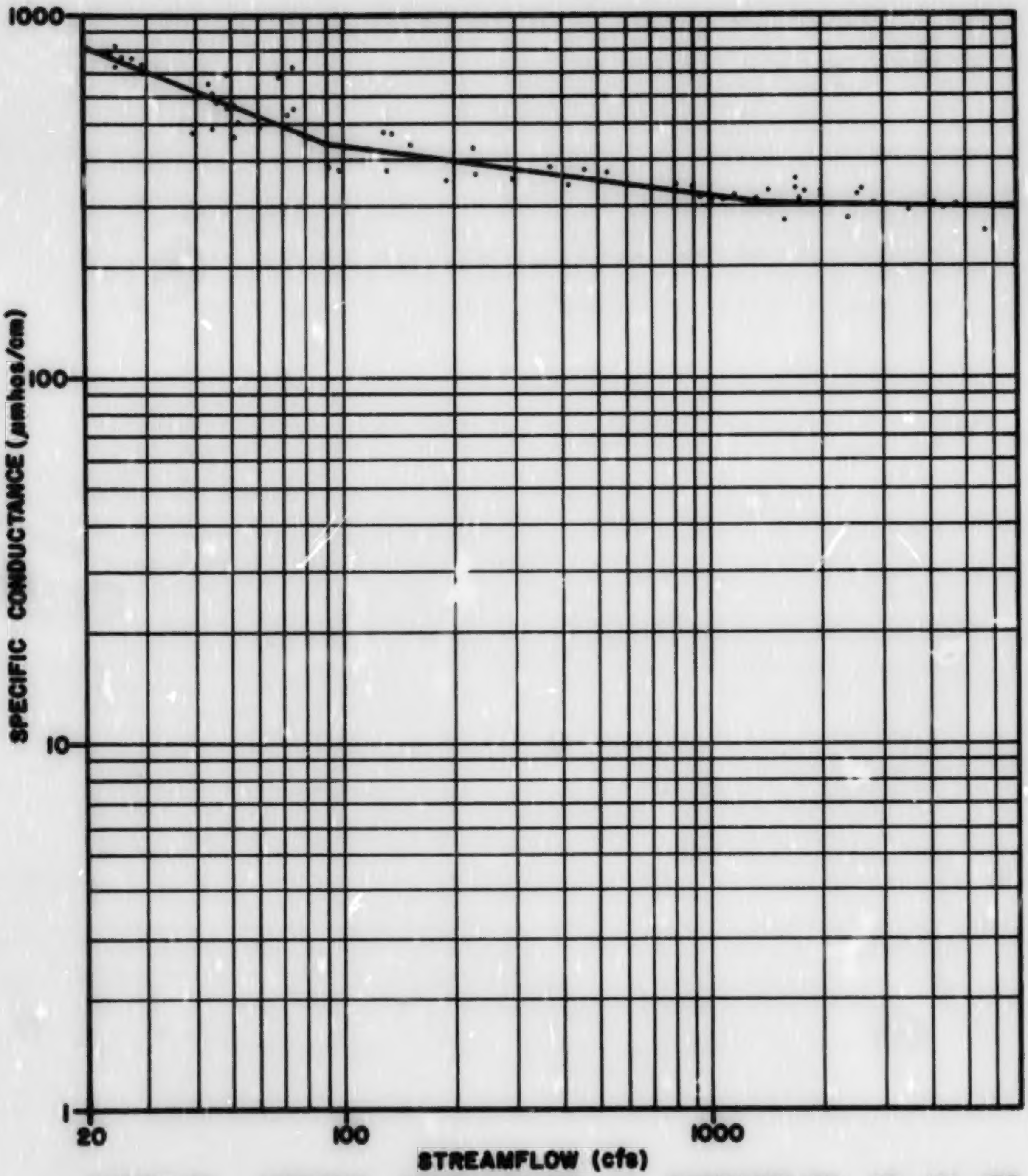


FIGURE E6. SPECIFIC CONDUCTANCE vs. STREAMFLOW AT US 175 NEAR CRANDALL.
(DATA FROM USGS 1972-1975)

Agricultural

The East Fork Trinity River is slightly used as a source of agricultural water. According to TRA (1974a) water rights permits for agricultural withdrawals from this segment total 8.02 x 10^5 cubic meters (650 acre-feet) per year.

Recreational

The East Fork Trinity River is very little used for recreation. A small section of the river between Lake Ray Hubbard dam and the confluence with Duck Creek carries water released from the lake and some game fishing occurs there. The remainder of this segment is very polluted and only a small amount of fishing for rough fish takes place.

Mining

The East Fork is slightly used as a source of water for mining and the recovery of minerals. According to TRA (1974a), one water rights permit has been issued in Kaufman County which allows a total of 1.85 x 10^5 cubic meters (150 acre-feet) of water per year to be used for mining and the recovery of minerals.

SUMMARY

The lower East Fork has consistently poor water quality. The TWQB (1976a) standards that were violated were dissolved oxygen and fecal coliform. The status of both of these parameters indicates serious water quality problems. In addition, the river carries high nutrient and BOD loads due to STP input upstream.

Tributary and sediment data also reflect the extent to which nutrients and other parameters pose a problem for the East Fork. Apparently, the sources of these problems are primarily Duck and South Mesquite Creeks. Available sediment data indicate that much of the oxygen-demanding material is located there.

Very little biological data (other than bacteria) were encountered for the East Fork. However, it may be postulated that, due to the severe stress conditions in the East Fork (particularly the low dissolved oxygen concentrations), a very low biological diversity exists there.

Historical water analyses indicate that present conditions in the East Fork have existed for some time.

ADDITIONAL DATA NEEDS

The available data are very limited for analyses of historical trends or point vs. nonpoint sources. Until last year, data were collected regularly at only one location, US 175 near Crandall. The North Texas Municipal Water District last year added several key locations to its monitoring program, greatly improving the total coverage. Additional data would be very desirable at the East Fork at IH 20. There is presently a USGS flow gage at that location, with which quality data could be correlated. Data at this site would indicate the quality of the river immediately downstream from Ray Hubbard Dam and the Duck Creek STP, and upstream from the influence of other point and nonpoint sources.

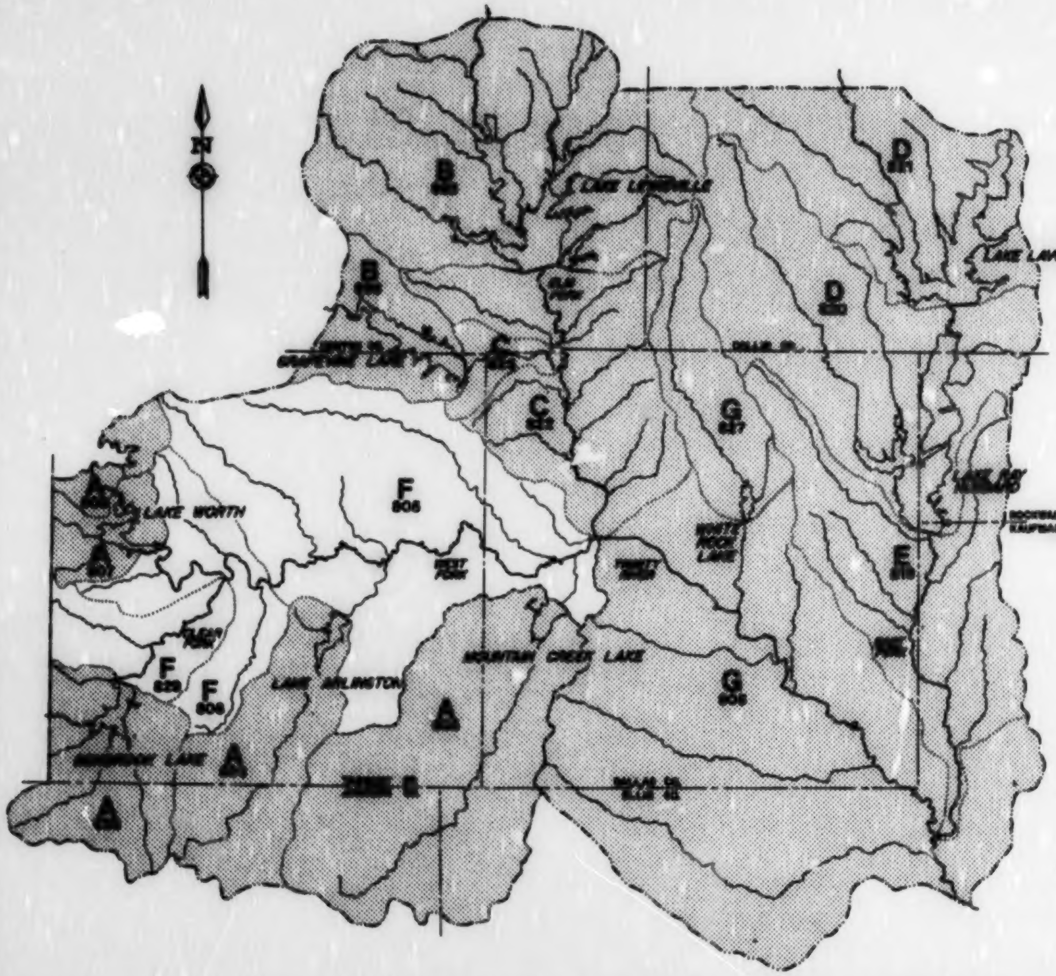
Additional data are required to analyze point vs. nonpoint sources. These data needs are generally the same as for segments in Presentation Areas F and G and are being covered in the continuing sampling design, prepared as a subsequent task under the same contract as this report. The data are to include frequent measurements of discharge, dissolved oxygen, oxygen demands, nutrients, and other parameters so as to determine the relationship of discharge and concentration with time throughout selected rainfall runoff events in the East Fork and in representative types of subwatershed areas. A key step in the development of these data is the installation of a continuous water quality monitor at the East Fork at US 175 near Crandall. The instrument was installed by the USGS during March 1977 under contract with the North Central Texas Council of Governments as a part of the overall 208 planning project, and it is to be continued with combined support of the USGS, the Texas Water Development Board, and local water agencies. The instrument will continually and automatically measure and record dissolved oxygen, temperature, conductivity, and pH, in addition to the stage/discharge gage already there.

PRESENTATION AREA F

WEST FORK BELOW LAKES

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

DELINEATION OF SEGMENTS AND PRESENTATION AREAS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WHITE ROCK LAKE
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ROCKWALL CO.
KAUFMAN CO.
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PRESENTATION AREA F - WEST FORK BELOW LAKES

SUMMARY

The three segments within Presentation Area F exhibit widely differing degrees of water quality. The West Fork from Beach Street in Fort Worth to the Elm Fork confluence exhibits characteristics associated with high sewage effluent loads: low dissolved oxygen, high nutrient and BOD values, and high fecal coliform concentrations. The West Fork from Worth Dam to Beach Street exhibits similar characteristics, but with less severity. The Clear Fork contains water of good quality, with consistently high dissolved oxygen concentrations. TWQB (1976a) criteria which were violated were dissolved oxygen (West Fork from Beach Street to the Elm Fork) and fecal coliform (West Fork from Worth Dam to Beach Street). It should be pointed out that the fecal coliform standard differs for these two portions of the West Fork. The standard is a log. mean of 2,000 organisms/100 ml for the West Fork from Beach Street to the Elm Fork and a log. mean of 200 organisms/100 ml for the West Fork from Worth Dam to Beach Street.

The majority of data available were for the West Fork from Beach Street to the Elm Fork. Heavy metal analyses were conducted on this reach, but not on the other two. However, no particular problems were revealed.

The majority of the tributary analyses were for Sycamore Creek and Marine Creek. A significant amount of input to the West Fork apparently comes from these two tributaries. Available tributary data for Bear Creek and Mountain Creek imply that little input to the West Fork comes from these two tributaries. No data were encountered for tributaries entering the Clear Fork.

Sediment data were available for both portions of the West Fork. Data indicated that significant amounts of nutrients and other high oxygen-demand materials were present in the sediment.

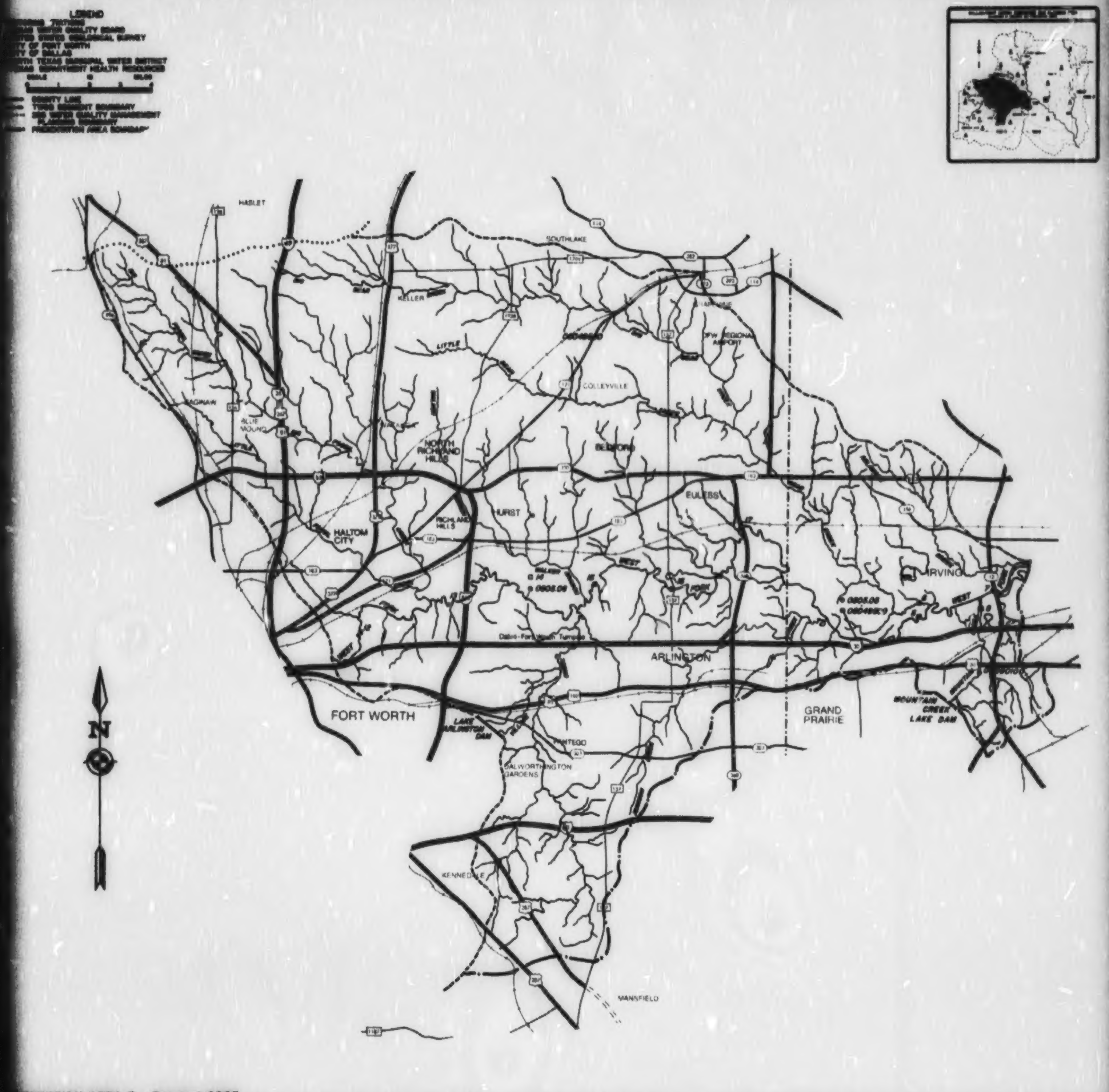
Biological data, where available, indicate there is a high degree of stress in the West Fork of the Trinity River. Organisms present are generally indicative of moderate to large amounts of gross organic pollution. Few biological data were encountered for the Clear Fork, but available fish data indicate that the types and numbers present reflect generally good water quality conditions.

Historical water analyses indicate that conditions have improved in both reaches of the West Fork over the past 50 years or so. This is particularly noticeable for the West Fork from Worth Dam to the Elm Fork, where mean dissolved oxygen concentrations show an increasing trend, while mean BOD values show a decreasing one.

Figures F1, F5, and F9 present maps of the West Fork from Beach Street to the Elm Fork, the West Fork from Worth Dam to Beach Street, and the lower Clear Fork, respectively, pinpointing existing monitoring stations.

MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Segment 0805			
DAL	West Fork at Meyers Road	5	A
DAL	Bear Creek at Meyers Road	6	A
DAL	West Fork at W. Loop 12	7	A
DAL	Mountain Creek at Singleton Blvd.	8	A
FW	West Fork at East First Street	12	C
FW	West Fork at Handley-Ederville Road	13	D
FW	West Fork at Precinct Line Road	14	D
FW	West Fork at Arlington-Bedford Road	15	D
FW	West Fork at SH 157	16	D
FW	West Fork at SH 360	17	C
TWQB	West Fork at W. Belt Line	0805.05	CaCcBaHbS
TWQB	West Fork at Randol Mill Road	0805.06	CaCcBd
USGS	West Fork at Grand Prairie	08049500	DdQOp
USGS	Big Bear Creek near Grapevine	08049550	Dd
USGS	Mountain Creek at Grand Prairie	08050100	Dd
Segment 0806			
FW	West Fork at White Settlement Road	3	A
FW	West Fork at N. Main Street	4	E
FW	West Fork at NE Twelfth Street	5	A
FW	West Fork at Samuels Avenue	6	A
FW	Marine Creek Bridge	7	B
FW	West Fork at NE Twelfth Avenue	8	A
FW	West Fork at E Fourth Street	9	A
FW	Sycamore Creek at US 80	10	A
FW	West Fork at Beach Street	11	D
TWQB	West Fork at Beach Street	0805.07	CaCcBaBcS
TWQB	West Fork at E. Northside Drive	0806.01	CaCc
TWQB	West Fork at River Oaks Blvd.	0806.02	CbMa
USGS	West Fork at Fort Worth	08048000	DdQpOp
USGS	Sycamore Creek at IH-35W	08048520	Dd
USGS	Sycamore Creek tributary at IH-35W	08048540	Dd
Segment 0829			
FW	Clear Fork TR @ CRA Bridge	1	A
FW	Clear Fork TR @ Pump Station	2	A
TWQB	Clear Fork TR @ Bryant-Irvin Street	0829.01	CcBd
USGS	Clear Fork TR near Benbrook	08047000	Dd
USGS	Clear Fork TR at Fort Worth	08047500	Dd


LEGEND
TEXAS WATER QUALITY BOARD
ITED STATES GEOLOGICAL SURVEY
TY OF FORT WORTH
TY OF DALLAS
RTH TEXAS MUNICIPAL WATER DISTRICT
XAS DEPARTMENT HEALTH RESOURCES
SCALE
MILES
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
PRESENTATION AREA BOUNDARY
HASLET
SOUTHLAKE
KELLER
GRAPEVINE
DFW REGIONAL AIRPORT
COLLEYVILLE
SAGINAW
BLUE MOUND
NORTH RICHLAND HILLS
BEDFORD
EULESS
HURST
RICHLAND HILLS
HALTOM CITY
IRVING
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0805.08
Dallas-Fort Worth Turnpike
ARLINGTON
FORT WORTH
GRAND PRAIRIE
MOUNTAIN CREEK LAKE DAM
LAKE ARLINGTON DAM
PANTEGO
DALWORTHINGTON GARDENS
KENNEDALE
MANSFIELD
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...NTATION AREA F - Segment 0805

TRINITY RIVER AUTHORITY OF TEXAS
Planning and Environmental Management Division

December 1976
FIGURE F1

WEST FORK TRINITY RIVER FROM BEACH STREET TO THE CONFLUENCE WITH THE ELM FORK - Segment 0805, Presentation Area F

For the purposes within this report, the Beach Street station will be considered part of Segment 0806. Water quality at this station is more reflective of that of Segment 0806 than Segment 0805.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Presentation Area F, West Fork Trinity River from Beach Street to the confluence with the Elm Fork Trinity River (DAL 5, 7; FW 12, 13, 14, 15, 16, 17; TRA; TWQB 0805.05, 0805.06; USGS 08049500). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	18.0	31.0	2.2	6.8	339
Dissolved Oxygen	6.1	18.2	0.0	**	333
pH (pH units)	7.4	8.3	6.8	0.3	375
Conductivity (umhos/cm)	861	1500	205	294	381
Total Suspended Solids	83	968	4	**	230
Volatile Suspended Solids	23	119	0	**	231
Total Dissolved Solids	460	929	110	193	355
Ammonia, as N	6.8	25.0	0.0	**	327
Nitrite, as N	0.46	1.10	0.00	**	25
Nitrate, as N	1.47	6.90	0.00	**	49
Organic Nitrogen, as N	2.15	14.00	0.80	**	21
Total Kjeldahl Nitrogen, as N	4.93	21.00	1.20	**	19
Total Phosphate, as P	3.4	10.1	0.1	**	94
Orthophosphate, as P	5.0	25.3	0.0	**	83
Chloride, as Cl	99	240	20	**	316
Sulfate, as SO_4	86	218	28	34	327
Total Alkalinity, as $CaCO_3$	265	300	26	87	187
Bicarbonate, as HCO_3	227	274	158	34	19
Carbonate Hardness, as $CaCO_3$	190	230	140	21	19
Noncarbonate Hardness, as $CaCO_3$	9	33	0	**	19
Chlorophyll a (ug/l)	14	58	0	**	20
Fecal Coliform (#/100 ml)	140*	1.5×10^6	0	**	140
Total Coliform (#/100 ml)	1.7×10^6	9.3×10^6	40	**	15
Color (Pt-Co units)	11	40	5	**	18
Turbidity (JTU)	36	296	1	**	223
Biochemical Oxygen Demand$_5$	14	53	1	**	300
Total Organic Carbon	35	105	1	**	159
Silica, as SiO_2	8.9	13	3.3	2.7	19
Calcium, as Ca	62	77	55	8	19
Magnesium, as Mg	8.2	10.0	4.7	1.6	19
Sodium, as Na	80	160	25	34	19
Potassium, as K	9.9	15	4.7	3.9	19
Sodium Absorption Ratio, SAR	2.6	5.0	0.9	1.0	19

continued. . .

Parameter	Mean	Max	Min	S	N
Fluoride, as F	1.0	2.7	0.1	**	17
Aluminum, as Al (ug/l)	22	50	10	**	6
Arsenic, as As (ug/l)	3	4	2	1	6
Boron, as B (ug/l)	245	450	90	95	6
Cadmium, as Cd (ug/l)	1.3	3.0	0.0	**	6
Chromium, as Cr (ug/l)	5	10	0	**	6
Cobalt, as Co (ug/l)	0	1	0	0	6
Copper, as Cu (ug/l)	5	8	3	2	6
Iron, as Fe (ug/l)	42	80	0	**	6
Lead, as Pb (ug/l)	2	4	0	2	6
Lithium, as Li (ug/l)	10	20	0	**	6
Manganese, as Mn (ug/l)	58	150	0	**	6
Mercury, as Hg (ug/l)	0.1	0.5	0.0	**	6
Nickel, as Ni (ug/l)	10	26	2	**	6
Strontium, as Sr (ug/l)	470	550	380	66	6
Zinc, as Zn (ug/l)	25	50	0	**	6

*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in the West Fork Trinity River (Segment 0805) were taken from TWQB (1976a).

Temperature - Not to exceed 35.0 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 2.0 mg/l. Criterion not met. The dissolved oxygen concentration was below 2.0 mg/l much of the time, and several values of 0.0 mg/l were reported.
pH - Acceptable range 6.5-8.5. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 850 mg/l. Criterion met.
Chloride - Mean concentration not to exceed 175 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 175 mg/l. Criterion met.
Fecal Coliform - Log. mean not to exceed 2000 organisms/100 ml. Criterion met.

Although the mean reported dissolved oxygen concentration was 6.1 mg/l, several values of 0.0 mg/l were reported, indicating substantial dissolved oxygen problems in this portion of Segment 0805. Nutrient and BOD values are high, due to the sewage effluent load carried by the river. Chlorophyll a concentrations went as high as 58 ug/l, a further indication of severe eutrophic conditions in the West Fork.

Figures F2 and F3 present recent river mile profiles in Segment 0805, Presentation Area F, for the parameters dissolved oxygen, biochemical oxygen demand, total organic carbon, chloride, conductivity, and ammonia. The parameters ammonia, biochemical oxygen demand, and total organic carbon show a sudden increase due to the Riverside STP, followed by a gradual decrease. Both chloride and conductivity exhibit a gradual increase throughout the reach.

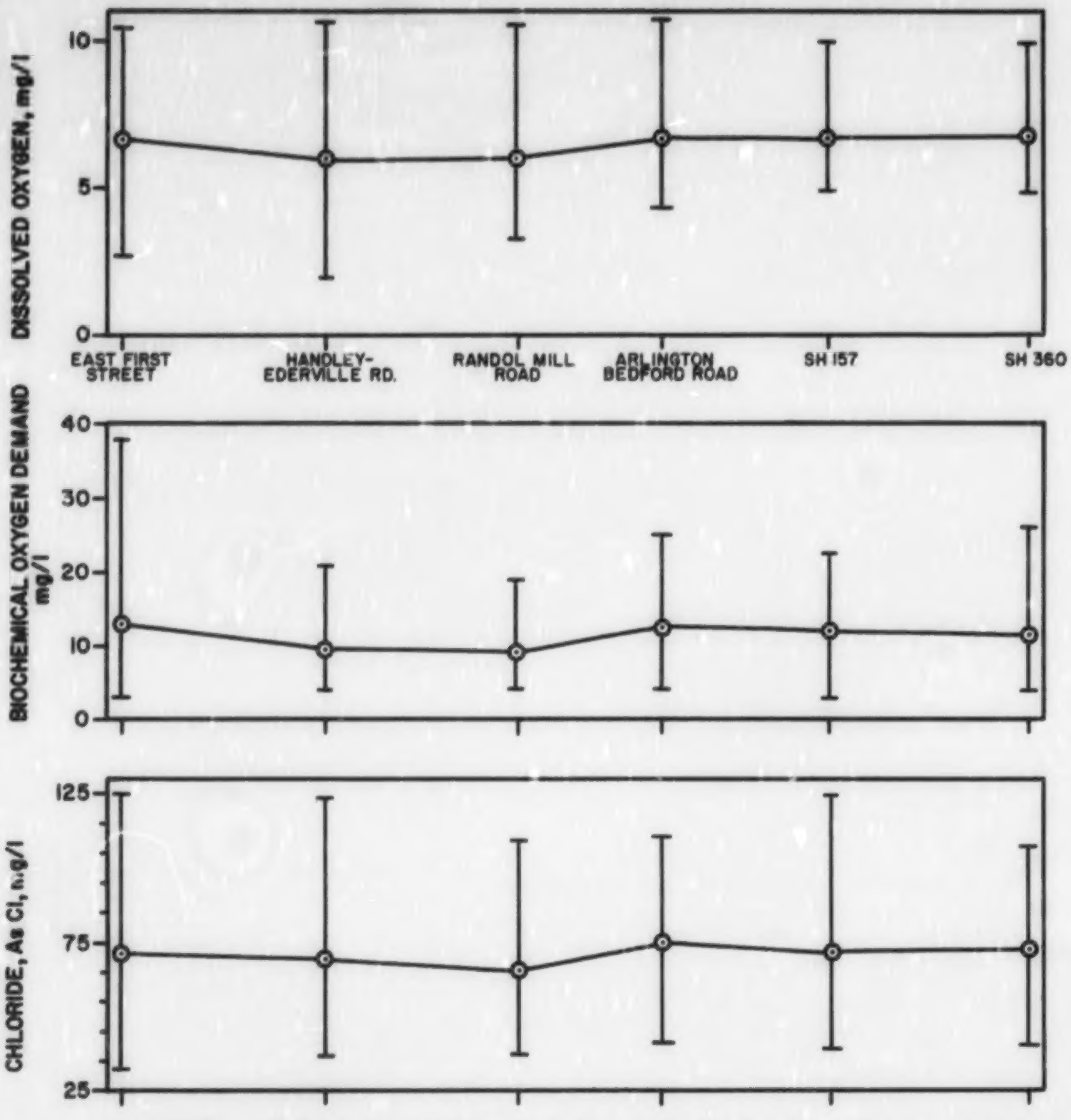


FIGURE F2. WEST FORK (SEGMENT 0805, PRESENTATION AREA F) PROFILES FOR DISSOLVED OXYGEN, BIOCHEMICAL OXYGEN DEMAND, AND CHLORIDE. VALUES PLOTTED ARE MEANS AND RANGES, AND THE PERIOD COVERED IS FROM 10-1-74 THROUGH 9-31-75.

(DATA FROM CITY OF FORT WORTH 1964-1976)

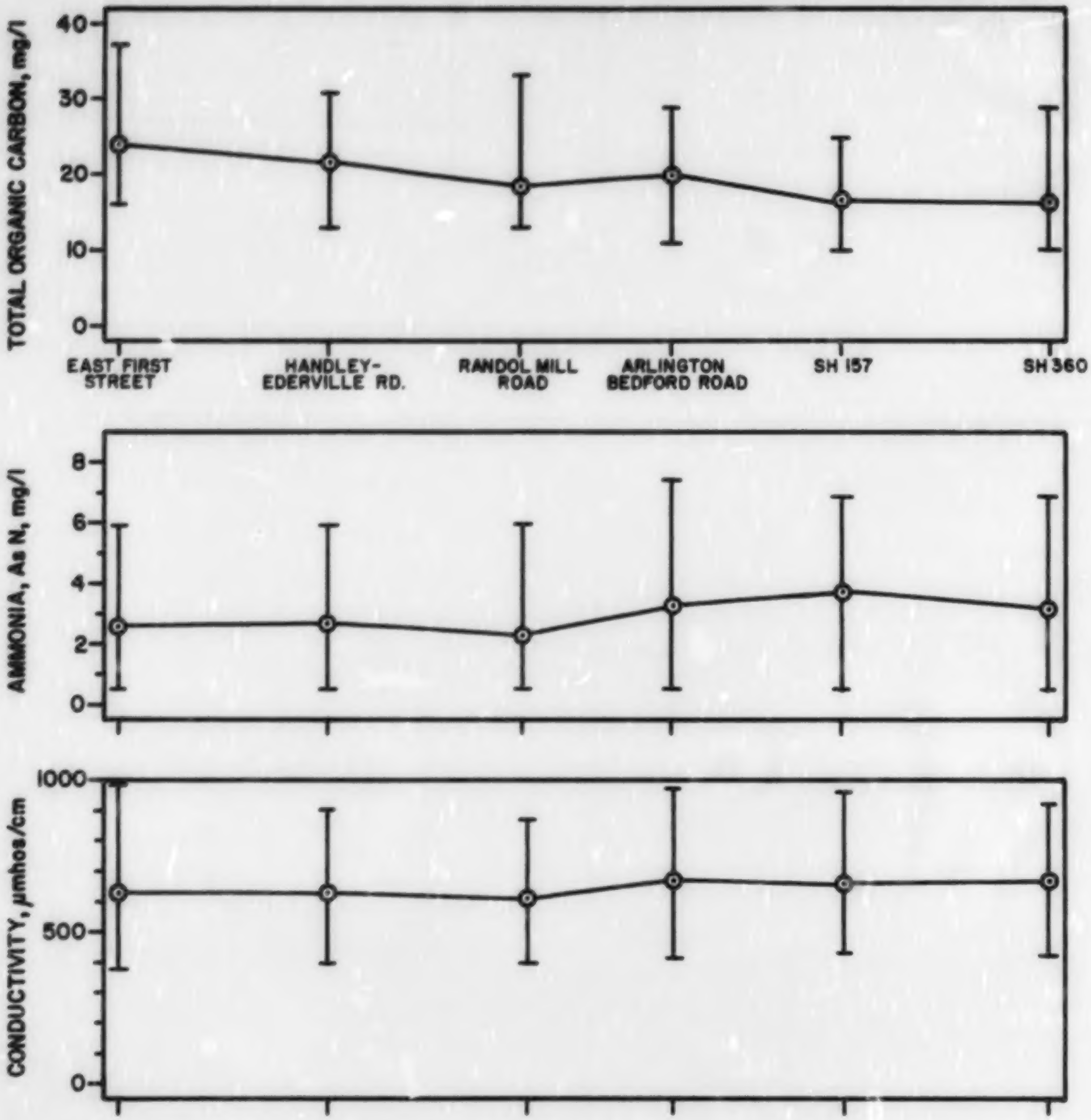


FIGURE F3. WEST FORK (SEGMENT 0805, PRESENTATION AREA F) PROFILES FOR TOTAL ORGANIC CARBON, AMMONIA, AND CONDUCTIVITY. VALUES PLOTTED ARE MEANS AND RANGES, AND THE PERIOD COVERED IS FROM 10-1-74 THROUGH 9-31-75.

(DATA FROM CITY OF FORT WORTH 1964-1976)

Tributary Water Analyses - The tributaries of this segment (0805, Presentation Area F) include Delaware Creek, Bear Creek, Johnson Creek, Walker Branch, Village Creek, Big Fossil Creek, Mountain Creek, and several small unnamed creeks. The USGS operates gaging stations on Big Bear Creek (USGS 08049550), Little Fossil Creek (a tributary of Big Fossil Creek) (USGS 08048850), and two stations on Mountain Creek (USGS 08049600 and 08049900). Of these four stations, the only two that produce water quality data are the Mountain Creek stations. Mountain Creek near Duncanville (USGS 08049900), Mountain Creek near Cedar Hill (USGS 08049600), and Mountain Creek Lake (USGS 08050050) are included in the Section on West Fork Lakes - Presentation Area A. Mountain Creek at Grand Prairie (USGS 08050100) is below Mountain Creek Lake Dam and is to be considered as part of this presentation area. However, the data at this station are exclusively discharge measurements.

The City of Dallas monitors the water quality at Big Bear Creek at Meyers Road (DAL 20) and Mountain Creek at Singleton Road (DAL 21). The following tables are a recent summary of the various water quality data reported for these two stations. All concentrations are in mg/l, unless otherwise specified.

Water Quality of
Mountain Creek at Singleton Road (DAL 21)
(1-1-76 through 6-30-76)

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.6	28.0	11.1	5.2	9
Dissolved Oxygen	11.9	15.4	7.2	2.4	9
pH (pH units)	7.9	8.2	7.6	0.2	9
Conductivity (umhos/cm)	785	1039	657	110	9
Orthophosphate, as P	0.06	0.20	0.00	**	9
Chloride, as Cl	54	92	24	20	9
Total Coliform (#/100 ml)	1740	4300	30	**	8
Total Organic Carbon	10	12	8	1	9
Turbidity (JTU)	21	28	5	6	9

**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality of
Big Bear Creek at Meyers Road (DAL 20)
(1-1-76 through 6-30-76)

Parameter	Mean	Max	Min	S	N
Temperature (C)	19.8	26.0	15.6	2.6	8
Dissolved Oxygen	8.3	10.8	7.0	0.7	8
pH (pH units)	7.9	8.1	7.7	0.1	8
Conductivity (umhos/cm)	677	1018	466	139	8
Orthophosphate, as P	0.29	0.90	0.00	**	8

continued. . .

Parameter	Mean	Max	Min	S	N
Chloride, as Cl	52	85	34	16	8
Total Coliform (#/100 ml)	10400	24000	1500	**	7
Total Organic Carbon	10	12	8	2	8
Turbidity (JTU)	27	67	3	**	8

**Data from a clearly non-normal distribution; no standard deviation computed.

Sediment Analyses - The following table summarizes recent sediment analyses conducted on the West Fork Trinity River at West Beltline Road in Grand Prairie (TWQB 0805.05). All concentrations are in mg/kg (dry weight), unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Oil and Grease	125	240	10	-	2
Organic Nitrogen	238	412	65	-	2
Phosphorus in Particulates	925	1200	650	-	2
Arsenic, as As	1.4	2.0	0.74	-	2
Barium, as Ba	1715	1715	1715	-	1
Boron, as B	5.3	5.3	5.3	-	1
Cadmium, as Cd	1.33	1.67	1.00	-	2
Chromium, as Cr	15.6	23.2	8.0	-	2
Copper, as Cu	24.9	41.8	8.0	-	2
Lead, as Pb	25.2	39.4	11.0	-	2
Manganese, as Mn	590	979	200	-	2
Mercury, as Hg (mg/kg, wet wt.)	0.0	0.0	0.0	-	2
Nickel, as Ni	22.6	35.2	10.0	-	2
Silver, as Ag	1.4	1.7	1.0	-	2
Selenium, as Se	0.9	0.9	0.9	-	1
Zinc, as Zn	54.7	86.4	23.0	-	2

-Standard deviation not computed when N is less than six.

Biological
(10-1-74 through 6-30-76)

Bacteria - Fecal and total coliform values were summarized in the WATER ANALYSES table. Recent fecal coliform data produced a log. mean of 140 organisms/100 ml. This is well below the TWQB (1976a) standard of 2000 organisms/100 ml. Values ranged from 0 to 1,500,000 organisms/100 ml for fecal coliform and from 40 to 9,300,000 organisms/100 ml for total coliform.

No other recent biological data were encountered for the West Fork from Beach Street to the confluence with the Elm Fork.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Historical data on the West Fork Trinity River are quite abundant for a number of parameters. However, analysis of historical water quality trends in the West Fork is complicated by 1) the strong relationships many parameters show with flow and 2) the high variation in flow exhibited by this portion of the Trinity River. In addition, laboratory and field methods have changed substantially over the years. Notwithstanding these difficulties, one may compare present river conditions to general (and often subjective) assessments made in the past.

The Texas Department of Health (1925) conducted an extensive survey of the Trinity River, making bacteriological, chemical, and visual assessments. Approximately 14 sites were utilized in the West Fork, which we now refer to as Segment 0805, Presentation Area F. Chemical and physical analyses conducted on this reach included measurements of dissolved oxygen, temperature, ammonia, nitrite, nitrate, solids, and alkalinity. Dissolved oxygen analyses for this portion of the West Fork produced a mean of 2.5 mg/l, a maximum of 6.8 mg/l, and a minimum of 0.0 mg/l (n = 28). Little can be said about other parameters, due to a lack of information concerning analytical methods and reporting units. The West Fork did, however, contain relatively high amounts of ammonia, but little nitrite or nitrate. This is generally indicative of a high sewage load.

Several bacterial analyses were conducted by THD (1925) in the West Fork from Beach Street to the Elm Fork. The total coliform counts produced ranged from 725,000 to 1,250,000 organisms/ml. This is equivalent to 72,500,000 to 125,000,000 organisms/100 ml, which is the present reporting mode.

In general terms, the water in this portion of the West Fork appears to have been considerably worse in 1924, according to THD (1925). Dissolved oxygen depression was more severe, coliform counts higher, and the river appears to have carried greater amounts of ammonia. Since that time, pollution controls and improved sewage treatment have resulted in improved conditions in the West Fork.

Texas Department of Health (1959) reported BOD_5 values in this portion of the West Fork ranging from less than 1 mg/l to greater than 30 mg/l. Mean dissolved oxygen concentrations ranged from 1.4 mg/l (n=21) at East First Street to 2.5 mg/l (n=15) at FM 157. The high and low DO concentrations for the study period were 12.3 mg/l at Randol Mill Road and 0.0 mg/l at Handley-Ederville Road respectively. TDH (1959) reported no bacterological analysis results.

It is anticipated that some chemical quality parameters have certain relationships with streamflow. As indicated above, high flow conditions are usually either directly or indirectly associated with rainfalls in the metroplex area. Rainwater, as it reaches the earth, is unable to dissolve many ions significantly; therefore, it may constitute a dilution for these ions to various segments within the area. Some ion concentrations are commonly inversely proportional to streamflow. Based upon historical data, regression techniques are often used to establish such relationships between variables.

A nonlinear model may be utilized to evaluate major ion concentration versus streamflow in Segment 0805. This model is presented as follows:

$$C = aQ^b$$

where C = ion concentration in mg/l,
Q = streamflow in cfs, and
a,b = regression coefficients (dimensionless)

An examination of the USGS chemical quality data at the Grand Prairie station (USGS 08049500) from 1967 to 1973 reveals that chloride, sulfate, sodium, total dissolved solids, and conductivity show apparent inverse relationships with streamflow. Conversely, bicarbonate, calcium, and hardness appear to be affected little by the flow.

Tributary Water Analyses - Historical water analyses within Segment 0805, Presentation Area F are available for Bear Creek. However, analyses have been conducted too infrequently to determine whether or not any trends exist in water quality. Historical water quality appears to have been good and fairly constant in Bear Creek.

TDH (1959) reported various analyses for Mountain Creek at US 80 and Village Creek at US 80. Sulfate concentrations as high as 260 mg/l were encountered in Mountain Creek. Both streams had ranges in DO concentration from about 4 mg/l to about 11 mg/l.

Sediment Analyses - Historical sludge analyses have been conducted in the West Fork from Beach Street to the Elm Fork by TRA (1972-1976). Table No. XXII summarizes the results of these sampling endeavors. For a comparison between these results and results of similar analyses on the Trinity River from the Elm Fork to SH 34 near Rosser, see Table No. XXX in Presentation Area G. Both of these sampling efforts were conducted during low flow conditions.

Biological
(Prior to 10-1-74)

Bacteria - Bacterial analyses from THD (1925,1959) were covered in the Historical CHEMICAL-PHYSICAL section. In addition, data from TRA (1972-1976) produced a mean fecal coliform concentration of 30,500 organisms/100 ml (n = 30) and a mean total coliform concentration of 111,700 organisms/100 ml (n = 32). The logarithmic mean fecal count for the same data was 175 organisms/100 ml. The maximum reported fecal coliform count was 650,000 organisms/100 ml, and the maximum reported total coliform count was 1,200,000 organisms/100 ml.

TABLE NO. XXII

SEDIMENT ANALYSES IN THE WEST FORK FROM BEACH STREET TO THE ELM FORK (SEGMENT 0805, PRESENTATION AREA F)

(Taken from TRA 1972, 1974c)

Parameter (Mean Values) mg/kg (dry weight)	Station			
	Arlington-Bedford Road	Above TRA Central STP	TRA Central STP	Below TRA Central STP
River Mile	505.2	482.9	482.8	482.5
Ammonia, as N			584	348
Nitrate, as N			4.9	18
Organic Nitrogen, as N			1,900	1,150
Orthophosphate, as P			212	370
Total Phosphate, as P			1,550	705
BOD_5	1,260	34,800	10,000	5,550
BOD_{20}	9,200			

TRA (1972-1976) reported a mean fecal streptococcus concentration of 550 organisms/100 ml (n = 11). McCullough (1973) reported a mean fecal streptococcus concentration of 5,200 organisms/100 ml (n = 7) for the West Fork at SH 360.

The overall trend in bacterial concentrations in this portion of the West Fork has been one of general improvement. However, periodic high values continue to occur.

Plankton - McCullough (1973) has reported phytoplankton species present at SH 360. The results of this sampling are presented in Table No. XXIII. The most common organisms are indicative of gross organic pollution, according to Palmer (1969).

McCullough (1973) also measured chlorophyll values at SH 360 in the West Fork. Mean total chlorophyll values ranged from a low of 15.3 ug/l in November to a high of 124.9 ug/l in March. Mean chlorophyll a values ranged from a low of 0.8 ug/l in November to a high of 24.0 ug/l in March. This is an indication of the eutrophic conditions frequently encountered in the West Fork.

McCullough (1973) reported periphyton diversity indices (Shannon-Wiener) of 0.85 and 1.5. Values in this range are indicative of moderate to severe stress, according to Wilhm and Dorris (1968). In addition, McCullough (1973) reported phytoplankton primary production rates of 2827 mgC/m^2/day in March and 492 mgC/m^2/day in January, both at SH 360.

Zooplankton diversity indices (Shannon-Wiener) reported for the West Fork at SH 360 ranged from a high of 2.4 in March to a low of 1.1 in January (McCullough 1973). Shannon-Wiener values within this range are indicative of moderate stress or pollution, according to Wilhm and Dorris (1968).

Aquatic Vegetation - No historical macrophyte studies were encountered for the West Fork between Beach Street and the confluence with the Elm Fork.

Macroinvertebrates - Benthic macroinvertebrates encountered at SH 360 by McCullough (1973) are presented in Table No. XXIV. For a comparison with benthic organisms encountered in the Trinity River between the Elm Fork and SH 34 near Rosser, see Table No. XXXII in Presentation Area G.

Fishes - Fullwood (1950) surveyed fish populations in the West Fork, primarily in an attempt to determine piscine parasitic infestation. Table No. XXV presents the results of his survey.

TABLE NO. XXIII

PHYTOPLANKTON ENCOUNTERED IN THE WEST FORK FROM BEACH STREET TO THE ELM FORK (SEGMENT 0805, PRESENTATION AREA F)

(Taken from McCullough 1973)

	RELATIVE ABUNDANCE*
Organism	SH 360
DIVISION CHLOROPHYTA	
Arthrodesmus incus	o
Chlamydomonas sp.	f
Chlorella sp.	d
Micractinium pusillum	o
Scenedesmus acuminatus	o
S. dimorphus	f
S. quadricauda	o
Tetradesmus sp.	o
DIVISION CHRYSOPHYTA	
Class Bacillariophyceae	
Diploneis smithii	r
G. parvulum	o
Melosira granulata	r
M. sp.	r
Navicula cryptocephala	f
N. rhynchocephala	r
Nitzschia acicularis	r
N. palea	d
DIVISION CYANOPHYTA	
Oscillatoria sp.	o
DIVISION EUGLENOPHYTA	
Euglena acus	o
E. ruba	f
E. sp.	r
Phacus acuminatus	f
P. longicauda	r

*d - dominant
a - abundant
f - frequent
o - occasional
r - rare

TABLE NO. XXIV

BENTHIC MACROINVERTEBRATES ENCOUNTERED IN THE WEST FORK FROM BEACH STREET TO THE ELM FORK (SEGMENT 0805, PRESENTATION AREA F)

(Taken from McCullough 1973)

Organism	ABUNDANCE SH 360
Annelida (misc.)	648
Tubificidae	1,879
Arthropoda	
Insecta	
Coleoptera larvae	1
Diptera	
Chironomidae larvae	20
Ceratopogonidae	56
Mollusca	
Gastropoda	
Ferrissia sp.	58
Pelecypoda	
Eupera sp.	1
Misc. Mollusca	30
Total Organisms Collected	2,693
No. Samples	5
Mean Diversity Index	0.48

TABLE NO. XXV

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR WEST FORK TRINITY RIVER (SEGMENT 0805)

(Taken From Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	16	1½"-2¼"
Notropis lutrensis Plains red shiner	37	1¼"-2½"
Ceratichthys vigilax (*Pimphales vigilax* (Baird & Girard)) Bullnose minnow (Bullhead minnow)	6	2½"-3"
Notemigonus crysoleucas Golden shiner	11	2"-4½"
Gambusia affinis Mosquitofish	37	1½"-2"
Lepomis macrochirus Bluegill	17	2"-2¼"
Lepomis megalotis Longear sunfish	6	2"-3½"
Lepomis humilis Orangespotted sunfish	13	3"-4"
Lepomis microlophus Redear sunfish	14	2½"-3¼"
Boleosoma chlorosomum (*Etheostoma chlorosomum* (Hay)) Bluntnose darter	7	1½"-2"
Megastomatobus cyprinella (*Ictiobus cyprinellus* (Valenciennes)) Big mouth buffalo (Largemouth buffalofish)	14	2"-3"
Cyprinus carpio Carp	9	1"-1½"
Dorosoma cepedianum Gizzard shad	45	3"-5½"

continued. . .

Species	Number Captured	Size Range
Schilbeodes nocturnus (*Nocturus nocturnus* (Jordan & Gilbert)) Freckled madtom	5	1"-1¼"
TOTAL	237	

No parasitic Copepoda were observed in or on the fish collected.

NONPOINT VS. POINT SOURCE LOADINGS

The West Fork Trinity River from Beach Street to the confluence with the Elm Fork is approximately 67.8 kilometers (42.1 miles) in length. It flows from the East edge of Fort Worth to the West edge of Dallas.

The streamflow in the West Fork is extremely variable between wet and dry periods in a given year, as evidenced by data from the USGS gaging station located at West Belt Line Road in Grand Prairie. Under low flow conditions, however, the streamflow in this segment is well regulated from releases (or lack of them) from Lake Arlington, Benbrook Lake, Mountain Creek Lake, and Lake Worth. These reservoirs occupy the main tributaries entering the West Fork and are also generally utilized for municipal raw water supplies. Major tributaries entering this portion of the West Fork include Big Fossil Creek, Village Creek, Bear Creek, and Mountain Creek.

This segment of the river also receives sewage effluent from three regional sewage treatment plants: Fort Worth Riverside, Fort Worth Village Creek, and TRA Central. Total sewage effluent from these plants contributes approximately 5.0 cubic meters per second (176 cfs) to the streamflow in the West Fork. Presently, the point source pollution of sewage treatment plants is responsible for the poor quality of the river at base flow. According to TWQB (1975-1976), there are two industrial and eleven domestic point sources with flows in excess of 0.002 cubic meters per second within this watershed. The water quality of the river is frequently worse in the rising front of a high flow produced by a heavy rainfall. The high flow not only loads nonpoint source pollutants from rural and urban runoff, but it also resuspends accumulated sludge from the river bottom. There is an immediate drop in dissolved oxygen and an overall deterioration in water quality.

Figure F4 depicts the relationship between total phosphorus and flow at the Grand Prairie station (USGS 08049500). It may be noticed that a significant amount of phosphorus appears to be associated with storm/runoff conditions. High phosphorus concentrations are characteristic of the rising front of the high flow; therefore, the peak of the flux profile occurs prior to the peak of the flow profile during a high flow event.

Because detention time is short in the segment during a high flow, an immediate impact from nonpoint source on water quality, except turbid appearance, seems insignificant. However, a large amount of various contaminants discharged into the river will exert a long-term effect.

WATER USES

Domestic and Municipal

The West Fork Trinity River from Beach Street to confluence with the Elm Fork is not used as a source of domestic and municipal water according to TRA (1974a).

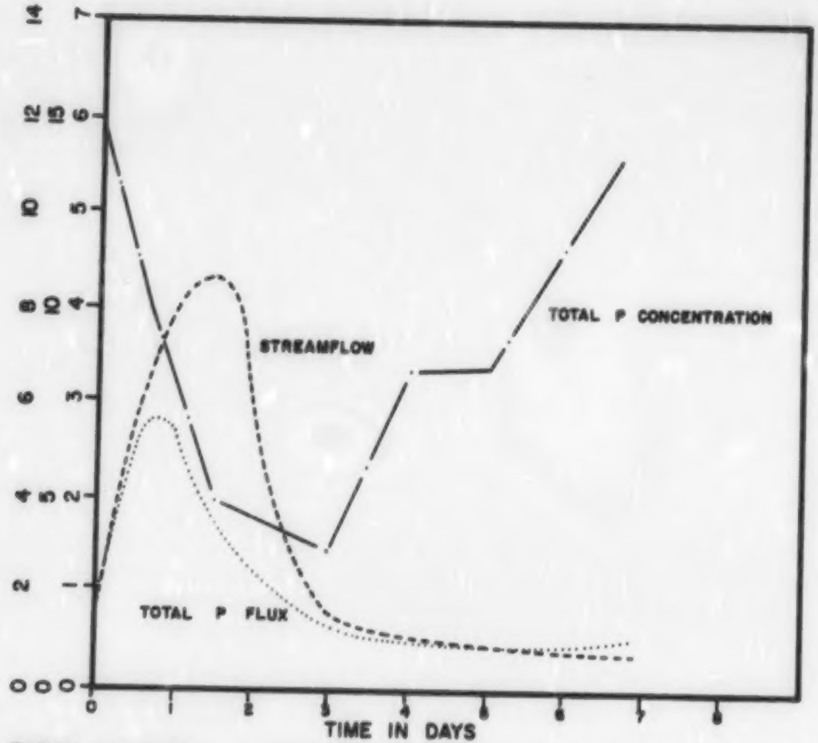


FIGURE F4. CONCENTRATION AND FLUX OF TOTAL PHOSPHORUS vs. STREAMFLOW AT WEST BELT LINE IN GRAND PRAIRIE (Sept. 26 - Oct. 3, 1973)
(DATA FROM TRA 1973)

Industrial and Agricultural

The West Fork (Presentation Area F) is not used as a source for either industrial or agricultural water. According to TRA (1974a), there are no water rights permits issued for the diversion of water for any use in this segment.

Recreational

The West Fork Trinity River from Beach Street to the confluence with the Elm Fork is little used for recreation. Due to the polluted state of the river, the only activities found in this segment are fishing for rough fish and hunting turtles.

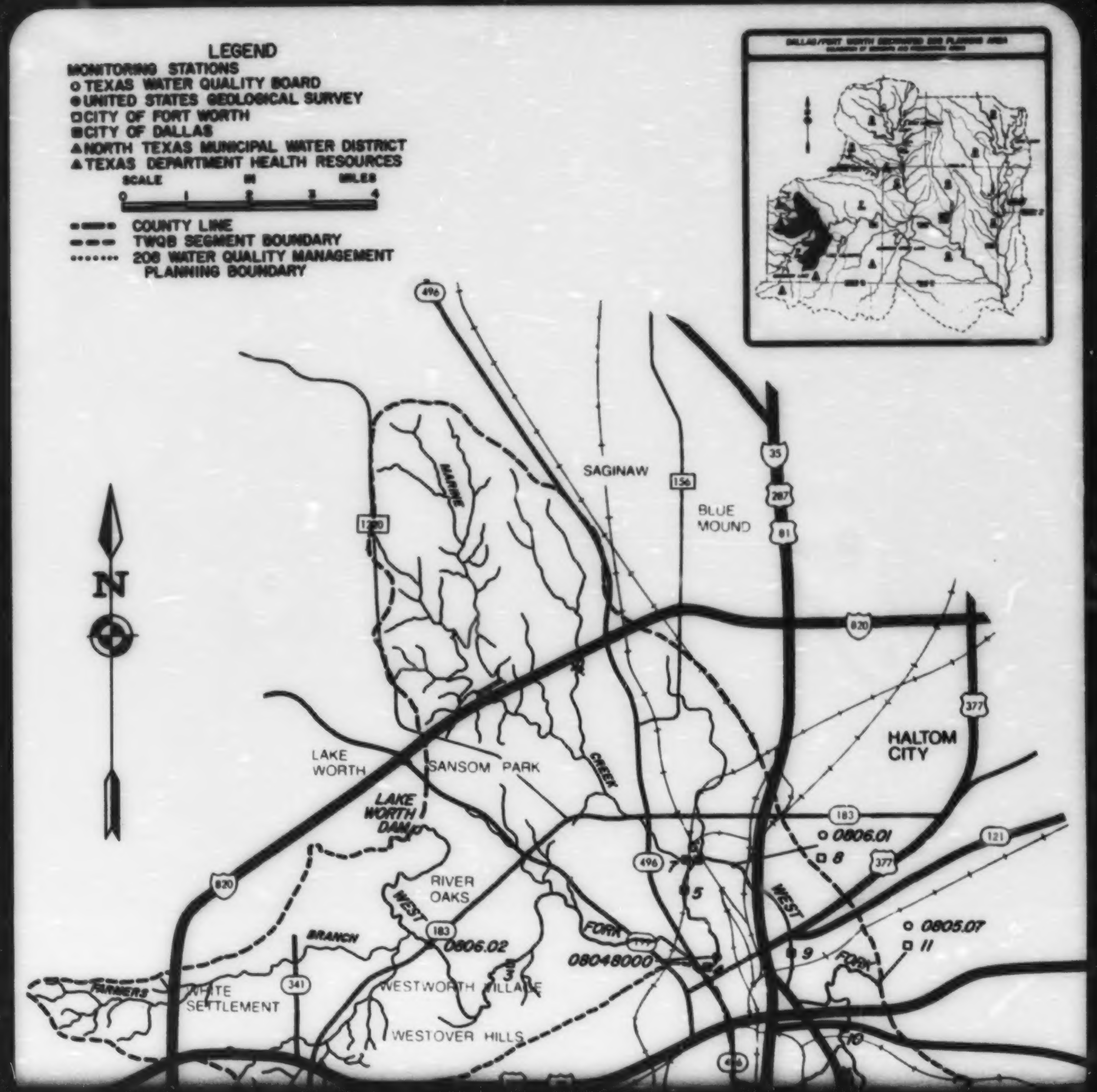
SUMMARY

Water quality in this portion of the Trinity River is characterized by several problems, including dissolved oxygen, nutrients, and bacteria. The only TWQB (1976a) standard that was violated was the one for dissolved oxygen. Due to the high sewage effluent load carried by this portion of the river and the resultant high BOD concentration, dissolved oxygen values of 0.0 mg/l were not uncommon. Average total nitrogen concentration for the West Fork was greater than 10 mg/l. Graphs of parameters versus river mile failed to reveal any trends, other than one of relative consistency.

Data available for tributaries entering this portion of the West Fork indicated that the water is of considerably better quality. Sediment data for the West Fork indicated that the bottom sediments serve as a significant sink of nutrients and other materials, such as heavy metals. This would constitute a significant source of these materials during high flow.

Recent biological data were limited to bacteria data. Quite a few high values were reported, although the TWQB (1976a) standard of 2,000 organisms/100 ml (log. mean) was met. Historical data indicated high fecal coliform counts have been the case for a number of years. Other historical biological data produced low diversity indices indicative of substantial stress upon the biological community.

Historical water analyses indicated that conditions in the river have improved over the last 50 years, although an analyses of trends over the more recent period (e.g., 10-20 years) is complicated by variations in flow among other things. Historical tributary and sediment analyses indicate that the past situation was very similar to the present.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
▲ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0
1
2
3
4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
N
SAGINAW
BLUE MOUND
HALTOM CITY
LAKE WORTH
SANSOM PARK
LAKE WORTH DAM
RIVER OAKS
WHITE SETTLEMENT
WESTWORTH VILLAGE
WESTOVER HILLS
MARINE
CREEK
WEST FORK
WEST
FORK
BRANCH
FARMERS
496
156
35
287
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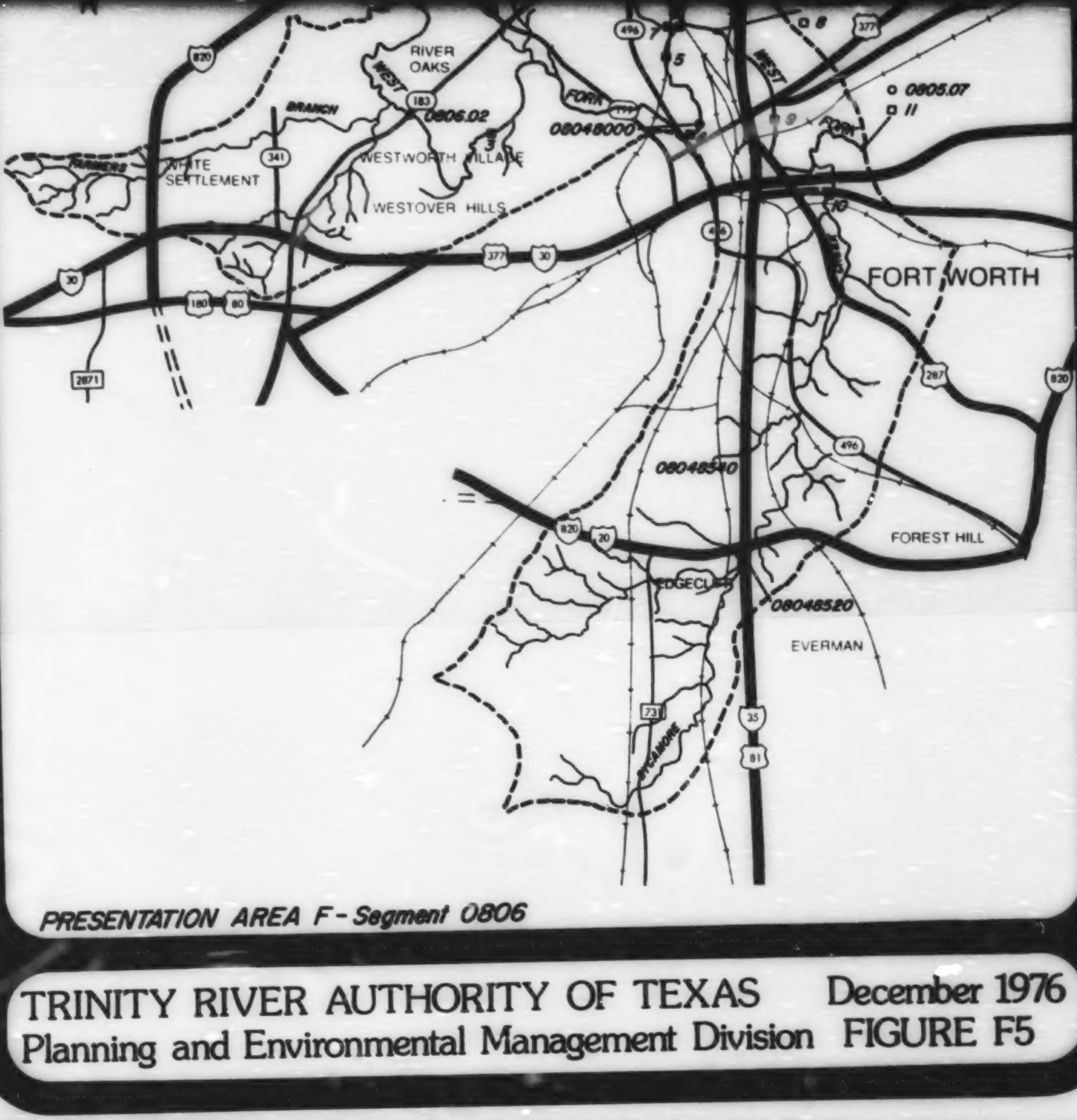
RIVER OAKS
WEST
FORK
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WHITE SETTLEMENT
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FOREST HILL
EDGECLIFF
EVERMAN
SYCAMORE
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731
35
81

PRESENTATION AREA F - Segment 0806

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE F5

WEST FORK TRINITY RIVER FROM LAKE WORTH DAM TO BEACH STREET - Segment 0806

For the purposes within this report, the Beach Street Station will be considered part of Segment 0806. Water quality at this station is more reflective of that of Segment 0806 than Segment 0805.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses West Fork Trinity River in Fort Worth (FW 3, 4, 5, 6, 7, 8, 9, 11; TWQB 0805.07, 0806.01, 0806.02; USGS 08048000). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	20.2	29.0	5.5	7.0	202
Dissolved Oxygen	8.9	14.6	5.5	2.2	192
pH (pH units)	7.6	8.3	7.0	0.3	261
Conductivity (umhos/cm)	449	2730	188	**	168
Total Suspended Solids	73	696	6	**	218
Volatile Suspended Solids	25	119	3	**	63
Total Dissolved Solids	320	580	164	101	54
Ammonia, as N	1.2	14.0	0.0	**	245
Nitrite, as N	0.01	0.08	0.00	**	28
Nitrate, as N	1.10	6.9	0.00	**	30
Organic Nitrogen, as N	0.76	1.30	0.25	0.27	28
Total Phosphate, as P	0.15	1.10	0.01	**	46
Orthophosphate, as P	0.10	0.80	0.00	**	16
Chloride, as Cl	67	226	10	**	245
Sulfate, as SO_4	61	270	18	**	245
Total Alkalinity, as $CaCO_3$	200	275	115	38	36
Bicarbonate, as HCO_3	192	262	137	30	28
Carbonate, as CO_3	0	0	0	0	28
Total Hardness, as $CaCO_3$	180	240	120	33	28
Noncarbonate Hardness, as $CaCO_3$	26	40	12	10	28
Fecal Coliform (#/100 ml)	540*	20000	10	**	32
Total Organic Carbon	27	130	5	**	97
Biochemical Oxygen Demand$_5$	5.3	27	0.8	**	234
Turbidity (JTU)	34	65	3	**	181
Sodium Absorption Ratio, SAR	0.8	1.2	0.5	0.2	28
Fluoride, as F	0.3	1.5	0.1	**	27
Calcium, as Ca	59	85	38	10	28
Magnesium, as Mg	6.9	9.4	3.0	1.5	28
Potassium, as K	4.2	5.2	3.0	0.6	28
Silica, as SiO_2	5.4	11	1.3	2.7	28
Sodium, as Na	25	40	13	8.1	28

*Log. mean to conform to standards.
**Data from a clearly non-normal distributon; no standard deviation computed.

Water Quality Standards - These standards for water quality in the West Fork from Lake Worth Dam to Beach Street (Segment 0806) were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.
pH - Acceptable range: 6.5 - 8.5. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met.
Chloride - Mean concentration not to exceed 100 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 100 mg/l. Criterion met.
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion not met. Out of 32 values reported, 24 exceeded the 200 organisms/100 ml standard. In addition, ten of the reported values were greater than 1000 organisms/100 ml. The maximum value was 20,000 organisms/100 ml.

Fecal coliform was the only parameter to violate TWQB (1976a) standards. Other parameters, particularly conductivity, ammonia, nitrate, and total organic carbon, had several high values each. The water in this segment was hard, ranging in total hardness from 120 mg/l to 240 mg/l, as $CaCO_3$.

Tributary Analyses - Tributaries entering the West Fork Trinity River and actually comprising part of Segment 0806 include Farmers Branch, Marine Creek, and Sycamore Creek. The Clear Fork Trinity River empties into this portion of the West Fork, but is a segment of its own (Segment 0829) and is covered in the section on Presentation Area F, Segment 0829, Clear Fork from Benbrook Dam to the confluence with the Trinity River.

The USGS operates two gaging stations on Sycamore Creek. The first of these stations (USGS 08048520) is located at Interstate 35-W and covers a drainage area of 45.8 square kilometers (17.7 square miles). The other station (USGS 08048530), actually on a tributary to Sycamore Creek, is located west of Seminary South Shopping Center and has a drainage area of 2.5 square kilometers (0.97 square miles).

The City of Fort Worth has conducted recent analyses on both Marine Creek (FW 7) and Sycamore Creek (FW 10). The following tables summarize available recent (10-1-74 through 6-30-76) data for these two stations. All concentrations are in mg/l, unless otherwise specified.

Water Quality of
Marine Creek

(Taken from City of Fort Worth 1949-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	16.6	27.2	5.6	5.7	25
Dissolved Oxygen	7.6	11.4	1.0	2.4	25

continued. . .

Parameter	Mean	Max	Min	S	N
pH (pH units)	7.6	8.0	7.0	0.24	25
Conductivity (umhos/cm)	1093	1461	536	280	25
Total Suspended Solids	104	603	4	**	25
Volatile Suspended Solids	41	214	1	**	24
Ammonia, as N	2.1	6.0	0.2	**	25
Chloride, as Cl	175	310	34	89	25
Sulfate, as SO_4	112	145	42	28	13
Total Alkalinity, as $CaCO_3$	292	415	174	81	25
Turbidity (JTU)	32	183	1	**	23
Biochemical Oxygen Demand$_5$	12	44	2	**	25
Total Organic Carbon	15	25	6	6	14

**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality of
Sycamore Creek at US 80

(Taken from City of Fort Worth 1949-1976)

Parameter	Mean	Max	Min	S	N
Temperature (C)	19.0	25.0	10.0	3.6	18
Dissolved Oxygen	8.4	10.4	7.1	1.0	18
pH (pH units)	7.6	7.9	7.2	0.2	26
Conductivity (umhos/cm)	503	760	199	132	26
Total Suspended Solids	65	508	5	**	26
Ammonia, as N	2.3	12.0	0.0	**	26
Chloride, as Cl	67	112	18	22	26
Sulfate, as SO_4	63	107	25	19	26
Turbidity (JTU)	36	210	2	**	26
Biochemical Oxygen Demand$_5$	5.1	17	1	**	26
Total Organic Carbon	27	65	4	**	14

**Data from a clearly non-normal distribution; no standard deviation computed.

Sediment Analyses - The following table summarizes recent sediment analyses conducted on the West Fork Trinity River (TWQB 0805.07). All concentrations are mg/kg (dry weight), unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Oil and Grease	843	843	843	-	1
Organic Nitrogen, as N	375	375	375	-	1
Phosphorus in Particulates	60	60	60	-	1
Arsenic, as As	3.23	6.30	0.16	-	2
Barium, as Ba	78	78	78	-	1
Boron, as B	0.72	0.72	0.72	-	1
Cadmium, as Cd	1.2	1.2	1.2	-	1

continued. . .

Parameter	Mean	Max	Min	S	N
Chromium, as Cr	14.2	14.2	14.2	-	1
Copper, as Cu	15.5	15.5	15.5	-	1
Lead, as Pb	323	323	323	-	1
Manganese, as Mn	301	301	301	-	1
Mercury, as Hg (mg/kg, wet wt.)	21	21	21	-	1
Nickel, as Ni	13.3	13.3	13.3	-	1
Selenium, as Se	2.58	2.58	2.58	-	1
Silver, as Ag	1.7	1.7	1.7	-	1
Zinc, as Zn	57.8	57.8	57.8	-	1

-Standard deviation not computed when N is less than six.

The West Fork sediments in Segment 0806 appear to be only slightly laden with these various elements, the exceptions being arsenic and lead. Compared with Segment 0805, there is considerably less organic nitrogen and phosphorus. Due to the small sample sizes, few inferences may be drawn from these data, but it is indicated that industrial waste may be an important source of pollution in this portion of the river.

Biological
(10-1-74 through 6-30-76)

Bacteria - Recent bacteria data for the West Fork Trinity River in Fort Worth were summarized in the WATER ANALYSES section. Reported data produced a maximum fecal coliform count of 20,000 organisms/100 ml and a logarithmic mean of 540 organisms/100 ml. This mean is well above the standard of 200 organisms/100 ml and indicates that this segment does receive some sewage effluent, either directly or indirectly.

No other recent biological data were encountered.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Historical trends are presented in Figure F6 for dissolved oxygen, biochemical oxygen demand, and chloride for the period 1950 to 1975. Dissolved oxygen appears to show an increase over the period, while BOD shows an apparent decrease. Chloride concentrations have failed to produce any problem in this section of the West Fork during the period 1965 to 1976.

Many of the other parameters now analyzed for by the City of Fort Worth do not have a historical record extending back as far as 1950. Others show no clearly definable trends or problems.

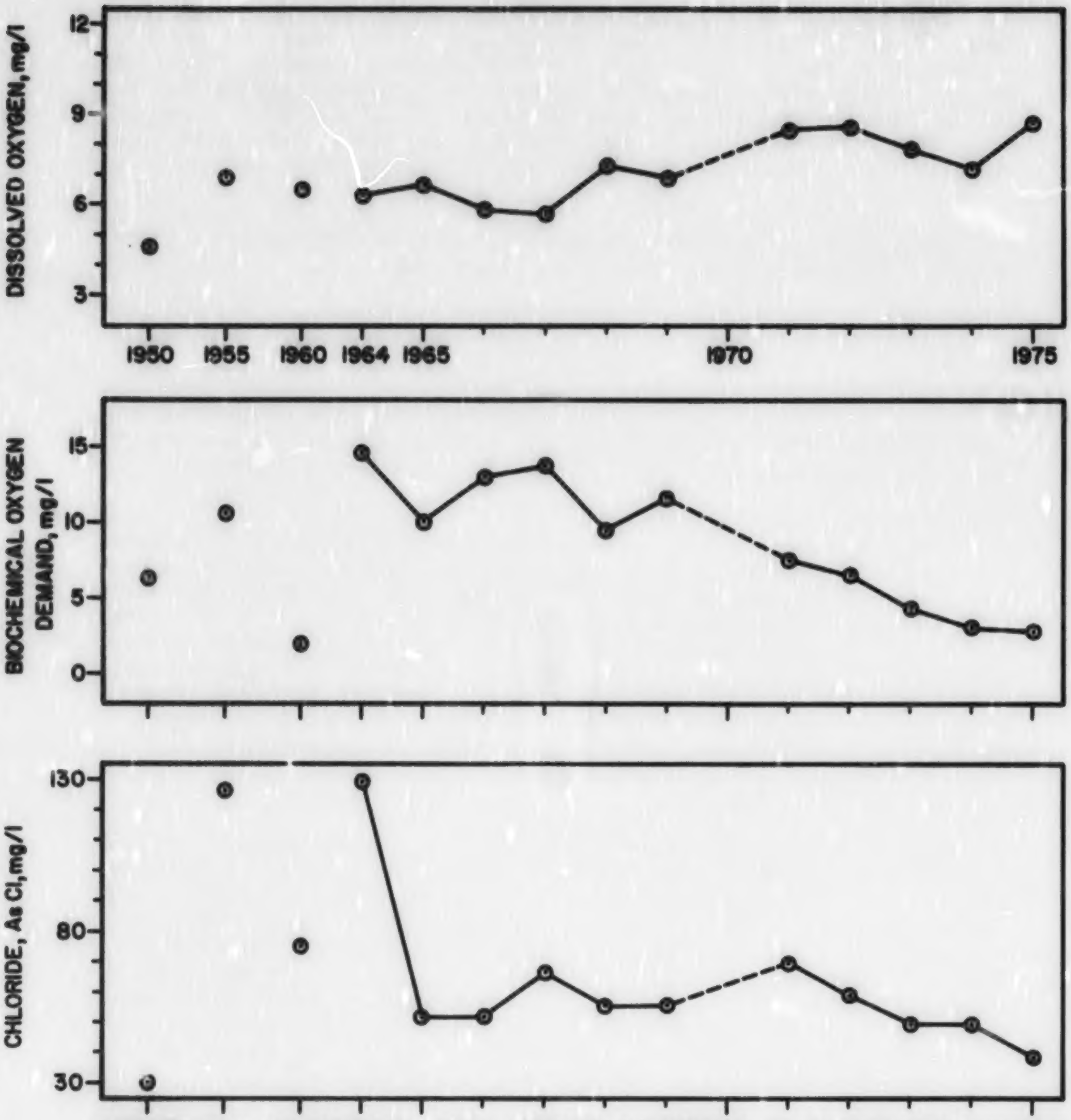


FIGURE F6. HISTORICAL DATA TRENDS EXHIBITED BY DISSOLVED OXYGEN, BIOCHEMICAL OXYGEN DEMAND, AND CHLORIDE AT WEST FORK (SEGMENT 0806). ALL VALUES PLOTTED ARE YEARLY MEANS.

(DATA FROM CITY OF FORT WORTH 1949-1976)

Tributary Water Analyses - Historical water quality trends for Marine Creek and Sycamore Creek are presented in Figures F7 and F8, respectively, for the parameters biochemical oxygen demand, dissolved oxygen, and chloride. The period covered for Sycamore Creek is 1964 to 1975 and the period covered for Marine Creek is 1950 to 1975. It may be noted that Marine Creek in particular often contributes water with high chloride, high biochemical oxygen demand, and low dissolved oxygen.

Sediment Analyses - Insufficient data were encountered for a trend analysis of sediment contaminants for Segment 0806.

Biological
(Prior to 10-1-74)

Bacteria - Fecal coliform bacteria data only go back to 1973, so nothing can be determined concerning bacterial trends in this portion of the West Fork. No other historical bacteria data were encountered.

Plankton - Rose (1941) surveyed the plankton community in Segment 0806 at two sites, one just upstream from the Clear Fork confluence and the other at the Marine Creek confluence. It was determined that rotifers and diatoms were the most abundant groups in the river. The station at the confluence with Marine Creek had a significantly greater abundance of *Vorticella* sp., *Euglena* sp., and various Myxophyceae, indicating that the water was more greatly polluted at this site. Common organisms at the upstream station included *Cyclops* sp., *Difflugia* sp., and various Chlorophyceae, indicative of relatively clean water.

Macroinvertebrates - Benthic organisms reported by Ryckman, *et al.* (1974) are presented in Table XXVI for two stations in Segment 0806. The Burgers Lake station, actually below a channel dam about two miles downstream from Lake Worth Dam, contains more benthic macroinvertebrates indicative of clean water than the Beach Street station. For instance, Resh and Unzicker (1975) list the genera *Stenonema* and *Argia* as being "facultative" and/or "intolerant" of gross organic pollution. These organisms were more prevalent at Burgers Lake than Beach Street. Similarly, *Helobdella* is listed as "tolerant" of gross organic pollution, and this genus was encountered only at Beach Street.

No other historical biological data were encountered for this portion of the West Fork.

NONPOINT VS. POINT SOURCE LOADINGS

This segment is a portion of the West Fork of the Trinity River with a reach of approximately 43 kilometers (27 miles) extending from Lake Worth to Beach Street. The principal tributaries of this segment are the Clear Fork, Marine Creek, and Sycamore Creek. These three tributaries

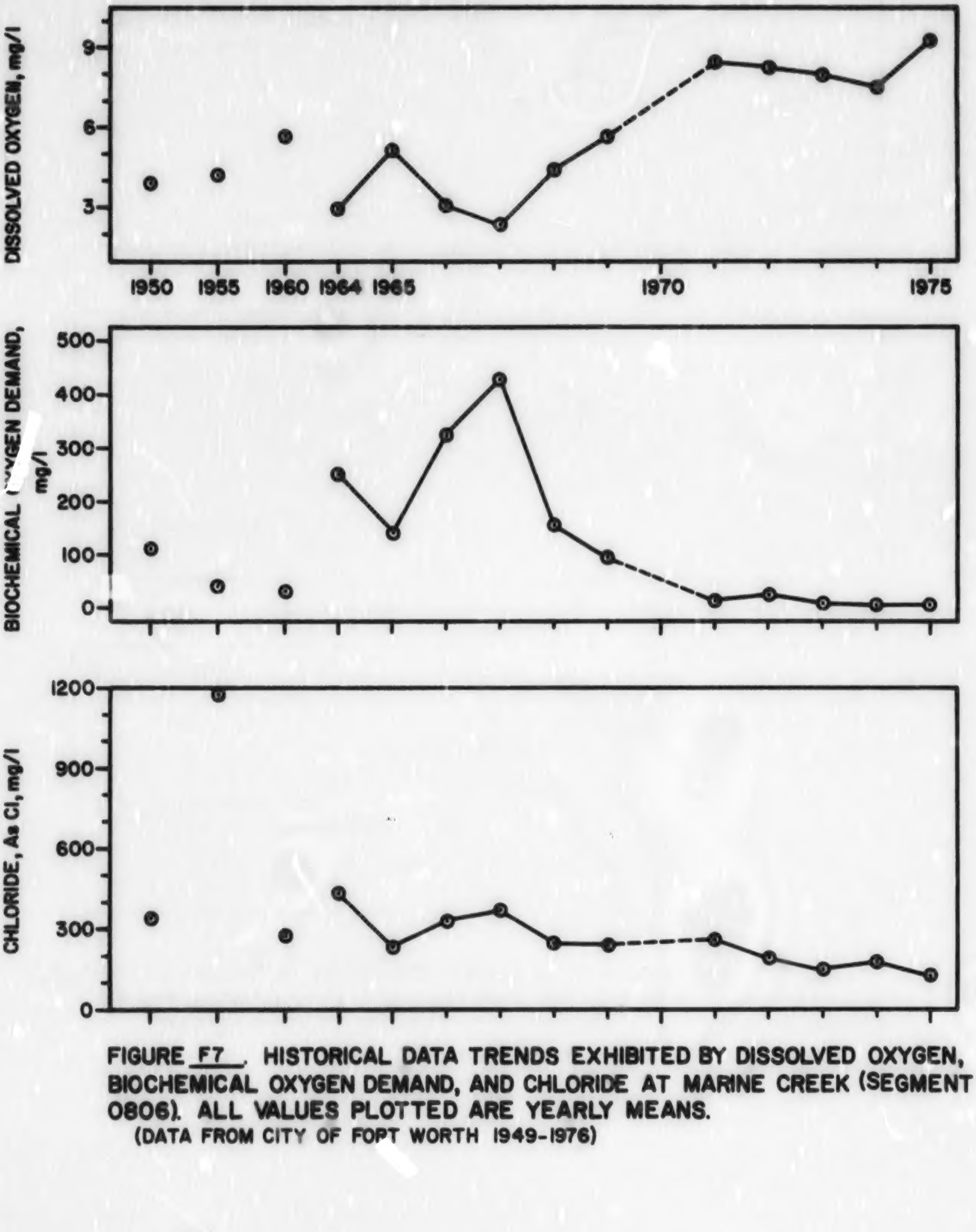


FIGURE F7. HISTORICAL DATA TRENDS EXHIBITED BY DISSOLVED OXYGEN, BIOCHEMICAL OXYGEN DEMAND, AND CHLORIDE AT MARINE CREEK (SEGMENT 0806). ALL VALUES PLOTTED ARE YEARLY MEANS.
(DATA FROM CITY OF FORT WORTH 1949-1976)

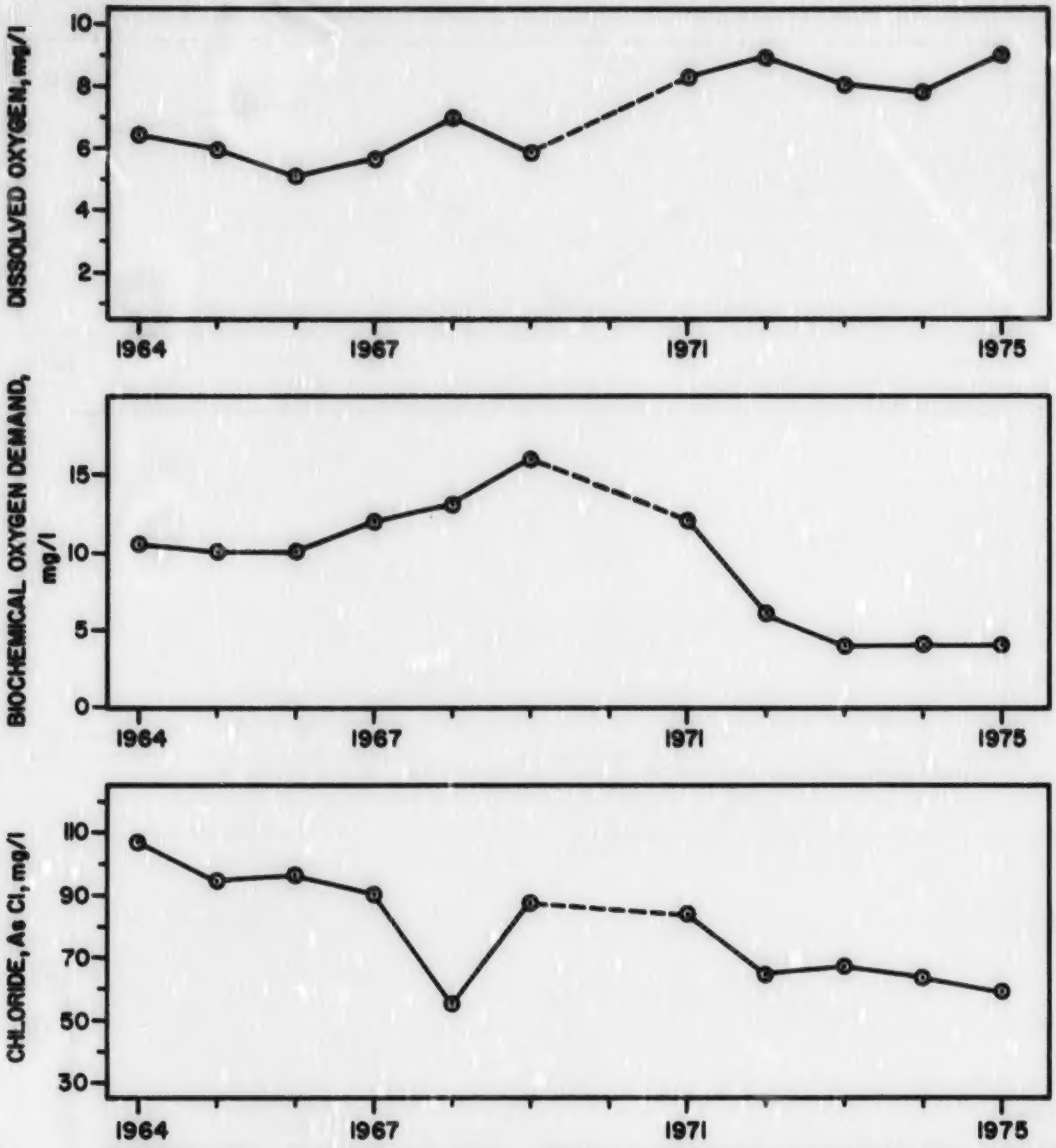


FIGURE F8 . HISTORICAL DATA TRENDS EXHIBITED BY DISSOLVED OXYGEN, BIOCHEMICAL OXYGEN DEMAND, AND CHLORIDE AT SYCAMORE CREEK (SEGMENT 0806). ALL VALUES PLOTTED ARE YEARLY MEANS.

(DATA FROM CITY OF FORT WORTH 1949-1976)

TABLE NO. XXVI

BENTHIC MACROINVERTEBRATES
(SEGMENT 0806)
(TAKEN FROM RYCKMAN, ET AL. 1974)

	ORGANISM ABUNDANCE	
Macroinvertebrate Species	Burger's Lake	Beach Street
Hydropsyche orris	a	a
Cheumatopsyche campyla	a	p-a
Chimarra obscura	p-a	a-p
Rhyacophilia sp.	a-p	p-a
Helicopsyche sp.	a-p	a
Brachycercus sp.		a
Baetis sp.	p	p-a
Stenonema heterotarsale	p	
Isonychia sp.	p	
Argia violacea		p-a
Argia sp.		p
Argia translata	a	a-p
Argia sedula	a	
Agrion maculatum	p	
Hetaerina americana	p	
Stenelmis sp.	p-a	p
Simulium occidentale	p-a	p-a
Simulium vittatum	p-a	
Pentaneura flavifrons		p-a
Chironomus plumosus		p-a
Tendipes tetans		p-a
Planaria sp.	p	
Ferrissia rivularis	p-a	
Musculium transversum	a	a
Psidium compressum	a	a-p
Physa integra		a-p
Helobdella elongata		p

p = present
a = abundant
p-a = usually listed as present, but occasionally listed as abundant
a-p = usually listed as abundant, but occasionally listed as present

feed into the lower portion of the segment near downtown Fort Worth. Therefore, water in the upper segment may reflect the quality of release water from Lake Worth Dam, while urban catchments of the tributaries can contribute a large amount of point and nonpoint source pollutants to the lower segment, and alter its ultimate water quality characteristics.

The USGS gaging station at Fort Worth (08048000), located about 16 kilometers (10 miles) below Lake Worth, exhibits a significant flow variation, ranging from less than 0.28 cubic meters per second (10 cfs) to greater than 283 cubic meters per second (10,000 cfs) with a median flow of about 0.85 cubic meters per second (30 cfs). Historical water quality data of both major chemical ions and nutrients reveal little difference between concentrations at low flow and concentrations at high flow. Again, because the area upstream from this station is beyond the cultural pollution of Fort Worth, the water quality at this station reflects to a high extent the release quality of Lake Worth.

Current USGS water quality data for 1974 and 1975 reveal that oxygen supersaturation had frequently been detected at the Fort Worth station (USGS 08048000), particularly for low flow conditions.

The City of Fort Worth has two weekly and four monthly sampling stations in Segment 0806. Available data from the city reveal a consistent trend in deteriorating water quality as the water goes downstream, particularly for TSS.

Taylor (1975) studied Sycamore Creek in Fort Worth and its influence as a nonpoint source on the West Fork Trinity River. Increased concentrations of coliform organisms, biochemical oxygen demand, and nutrients resulted from urban runoff and stormwater. Maximum values reported for BOD, nitrate-nitrogen, and orthophosphate were, respectively, 81 mg/l, 2.64 mg/l, and 0.75 mg/l.

As far as nonpoint source pollutants are concerned, there are no controlled data developed and available for any assessment. It is believed that urban runoff from the Clear Fork, Marine Creek, and Sycamore Creek can contribute a significant amount of pollutants to the segment during a rainfall event.

According to TWQB (1975-1976), there exist two industrial and no domestic point sources within this watershed.

WATER USES

Domestic and Municipal

The West Fork Trinity River from below Lake Worth Dam to Beach Street is not used as a source of domestic and municipal water. However, the City of Fort Worth does possess a Certified Filing which allows them to remove water from the West Fork and the Clear Fork Trinity River.

Industrial

The West Fork Trinity River (Segment 0806) is moderately used as a source of industrial water. The sole user is Texas Electric Service Company. Water rights permits for industrial water from this segment total 1.35 x 10^5 cubic meters (1,095 acre-feet) per year. This water is used to cool electrical generator steam condensing towers and in doing so a calculated average of 0.03 cubic meters per second (0.7 MGD) are consumed by evaporation.

Agricultural

The West Fork (Segment 0806) is moderately used as a source of water for agricultural purposes. According to present records, there are 22 permits issued allowing water diversion for agricultural use. The maximum rates of diversion for the permits range from 0.01 to 0.25 cubic meters per second (0.01 to 8.9 cfs).

Recreational

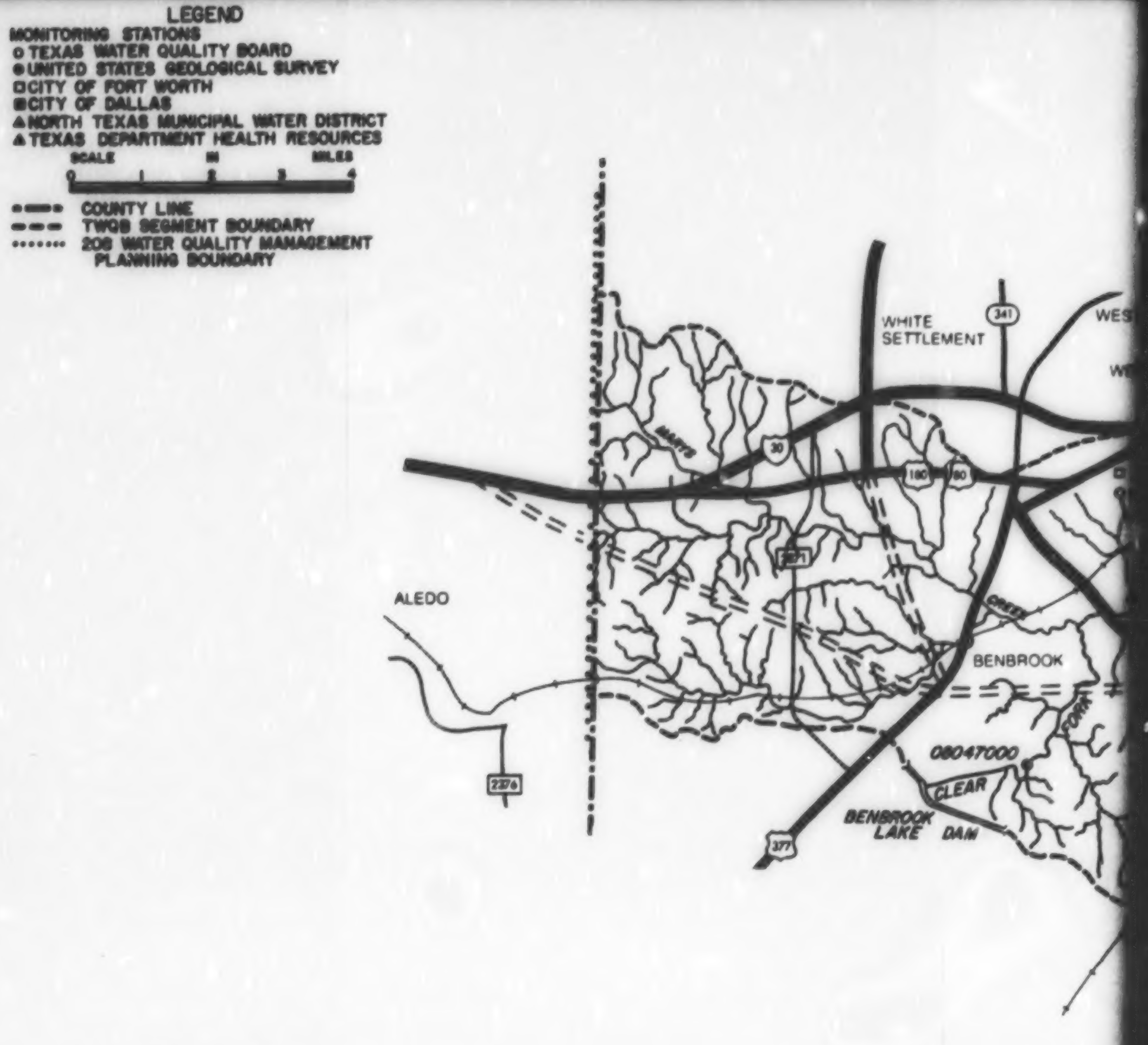
The West Fork (Segment 0806) is moderately used for recreation. Activities in this segment include fishing, canoeing, and a small amount of swimming.

SUMMARY

Water quality in the West Fork in Fort Worth exhibits moderate nutrient concentrations and high fecal coliform counts. The standard of 200 organisms/100 ml for fecal coliform was the only TWQB (1976a) standard violated. Dissolved oxygen values in this portion of the West Fork are good. All in all, the water quality in this portion of the West Fork is better than that in the West Fork from Beach Street to the Elm Fork. This is due largely to the fact that Fort Worth Riverside STP, Fort Worth Village Creek STP, and TRA Central STP all discharge into the latter segment.

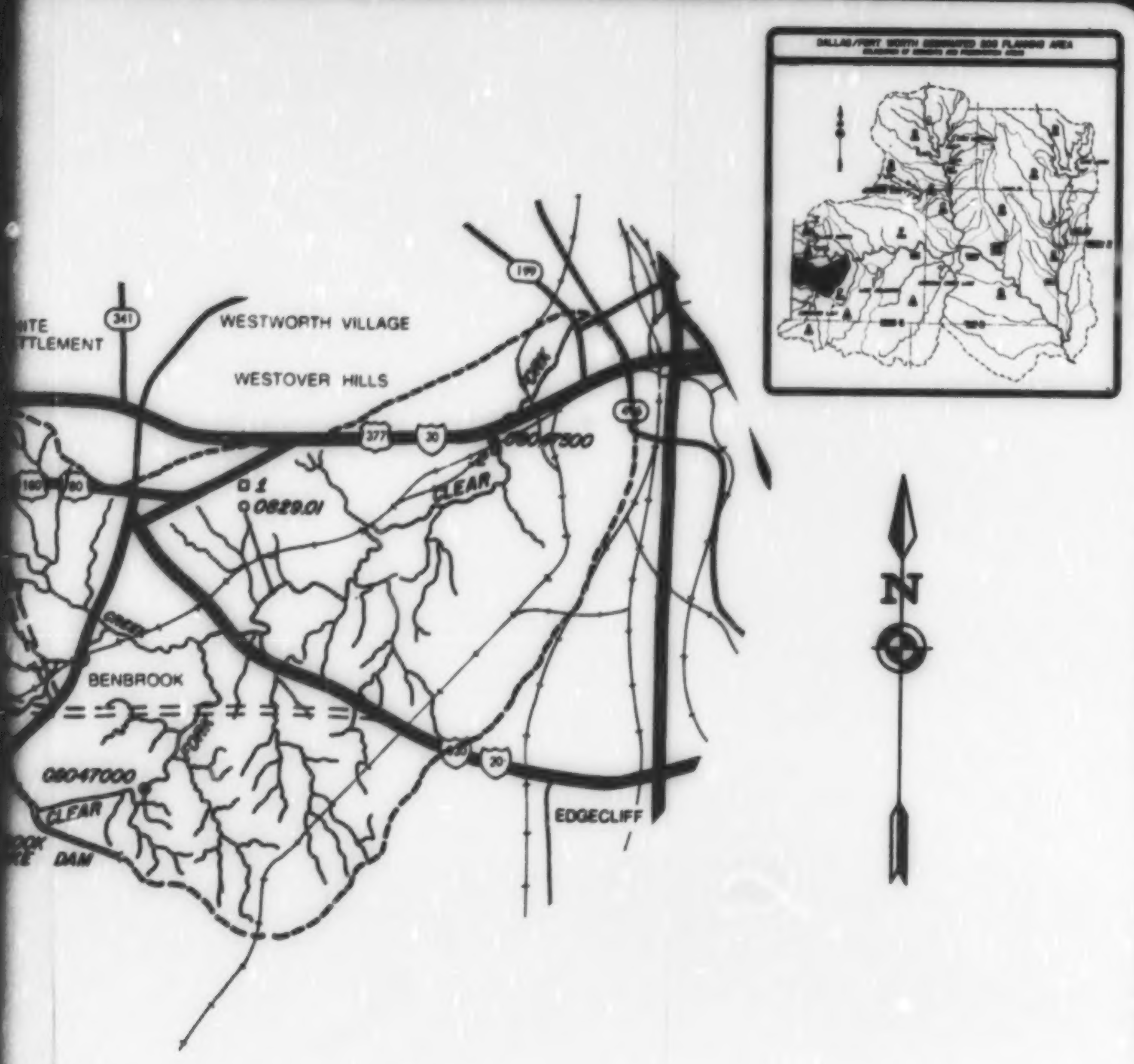
Marine and Sycamore Creeks contribute relatively high concentrations of nutrients and BOD to the West Fork. Sediment analysis data, while few, seemed to indicate the presence of significant concentrations of nutrients.

Very little biological data were encountered, other than bacterial data. Historical fecal coliform data were insufficient in quantity to conclude much concerning past concentrations. Historical water quality analyses for the parameters dissolved oxygen and BOD show what appear to be increasing and decreasing trends respectively. Other parameters appear to show a relative consistency over their respective periods of record. Historical analyses for the tributaries Marine Creek and Sycamore Creek show the same increasing trend for dissolved oxygen, as well as the decreasing trend for BOD. In addition, Sycamore Creek reveals a decreasing trend in chloride concentration for the period of record.


LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY
WHITE SETTLEMENT
341
WES
30
180
80
2871
ALEDO
BENBROOK
CREEK
FORK
08047000
CLEAR
BENBROOK LAKE DAM
377
2376

PRESENTATION AREA F - Segment 0829

TRINITY RIVER AUTHORITY OF T
Planning and Environmental Managemen


ITE
TTLEMENT
341
WESTWORTH VILLAGE
WESTOVER HILLS
199
377
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08047500
CLEAR
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CREEK
BENBROOK
820
20
08047000
CLEAR
ROOK
KE
DAM
EDGECLIFF
N
DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA

TY OF TEXAS December 1976
Management Division FIGURE F9

F-34

CLEAR FORK TRINITY RIVER BETWEEN BENBROOK DAM AND CONFLUENCE WITH THE WEST FORK TRINITY RIVER - Segment 0829

Benbrook Dam was constructed during the period 1947 to 1950. Since that time, flow in the lower Clear Fork has been largely regulated by releases from Benbrook Dam.

Historically, the Clear Fork has been by far the cleanest portion of the Trinity River. This has been aided by the fact that there are no direct point source discharges of domestic and municipal wastewater into this segment. The lower Clear Fork has had consistently high dissolved oxygen values as well as a relatively high degree of clarity.

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Clear Fork Trinity River (FW 1, 2; TWQB 0829.01) All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	17.9	27.2	9.0	5.8	34
Dissolved Oxygen	9.2	13.2	7.2	1.4	34
pH (pH units)	7.8	8.2	7.3	0.23	34
Conductivity (umhos/cm)	425	557	280	82	34
Total Suspended Solids	59	309	10	**	31
Volatile Suspended Solids	6	12	0	**	7
Total Dissolved Solids	230	262	140	46	10
Ammonia, as N	0.49	1.40	0.00	**	31
Nitrate, as N	0.12	0.33	0.00	**	7
Total Phosphate, as P	0.18	0.64	0.02	**	7
Orthophosphate, as P	0.08	0.15	0.02	**	7
Chloride, as Cl	27	91	15	6	24
Sulfate, as SO_4	37	56	21	12	7
Chlorophyll *a* (ug/l)	5	11	2	**	7
Fecal Coliform (#/100 ml)	103*	3570	10	-	5
Biochemical Oxygen Demand$_5$	2	4	1	1	24
Turbidity (JTU)	24	68	7	**	25

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in the Clear Fork Trinity River (Segment 0829) were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion met.

pH - Acceptable range: 6.5 - 8.5. Criterion met.

Total Dissolved Solids - Mean concentration not to exceed 500 mg/l. Criterion met (no reported values in excess of 500 mg/l).

Chloride - Mean concentration not to exceed 100 mg/l. Criterion met (no reported values in excess of 100 mg/l).

Sulfate - Mean concentration not to exceed 100 mg/l. Criteria met (no reported values in excess of 100 mg/l).

Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

Water quality in the lower Clear Fork is apparently quite good. Dissolved oxygen values are consistently high, and no other parameters are in violation of the TWQB (1976a) standards. Nutrient concentrations, particularly ammonia, are fairly high, but appear to cause no eutrophic symptoms.

Tributary Water Analyses - Tributaries flowing into the Clear Fork Trinity River and included in the 208 area include Marys Creek and several small unnamed tributaries. No existing data for these creeks were encountered. The majority of water found in the lower Clear Fork is released from Benbrook Lake, the quality of which is quite good and presented in the section on Segment 0830.

Sediment Analyses - No data regarding the concentrations of contaminants in sediment were encountered for the Clear Fork.

Biological
(10-1-74 through 6-30-76)

Bacteria - Available bacterial data were presented in the WATER ANALYSES section. The logarithmic mean for the fecal coliform data was 103 organisms/100 ml. This is well below the established standard for Segment 0829 of 200 organisms/100 ml. The maximum measured and reported fecal count was 3570 organisms/100 ml, and the minimum reported count was 10 organisms/100 ml.

No other recent data pertaining to the biota of the Clear Fork Trinity River were encountered.

HISTORICAL DATA SUMMARY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Figure F10 depicts historical trends of three parameters measured over a period of ten years for the Clear Fork Trinity River. The combination of the results of these graphs, namely a relatively high dissolved oxygen concentration and low values of biochemical oxygen demand and chloride ions, indicate that the water in this segment is of good quality.

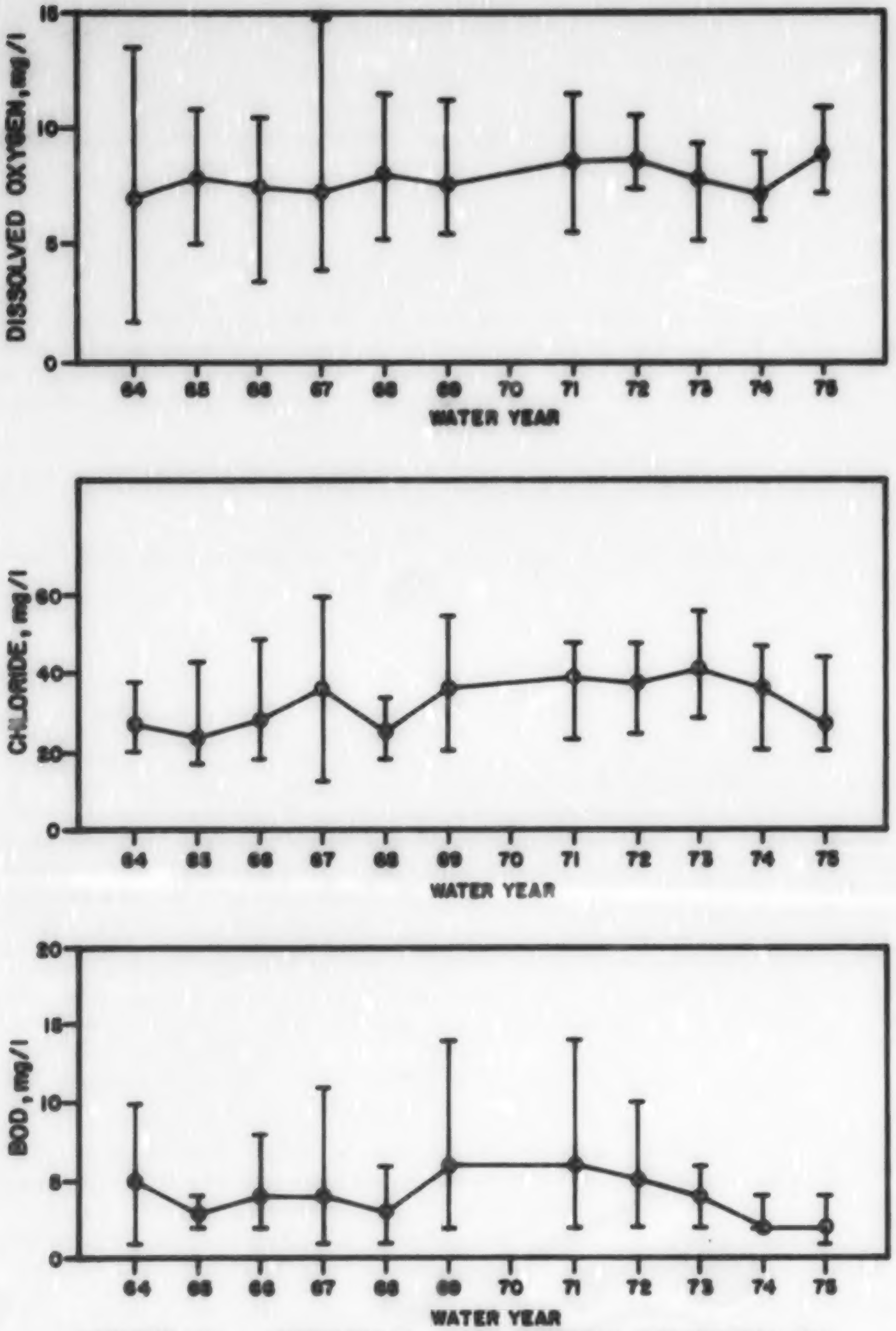


FIGURE F10. HISTORICAL DATA TRENDS EXHIBITED BY DISSOLVED OXYGEN, CHLORIDE, AND BOD FOR THE CLEAR FORK TRINITY RIVER (Segment 0829). DATA PLOTTED ARE MEAN VALUES AND RANGES.

(DATA FROM CITY OF FORT WORTH 1964-1975)

Tributary Analyses - No historical data were encountered for the tributaries in Segment 0829.

Sediment Analyses - No historical sediment data were encountered for the Clear Fork Trinity River.

Biological
(Prior to 10-1-74)

Fishes - Kelly (1975) surveyed fishes at three stations along the lower Clear Fork. The results of this survey are presented in Table XXVII. It may be noted that the station nearest Benbrook Dam had the greatest number and variety of fishes. The mosquitofish (Gambusia affinis) was the most abundant species encountered.

The results of the TPWD (1957b) fish survey of the lower Clear Fork are presented in Table No. XXVIII.

No other historical biological data were encountered for the lower Clear Fork.

NONPOINT VS. POINT SOURCE LOADINGS

Segment 0829, the Clear Fork Trinity River from Benbrook Dam to the confluence with the West Fork Trinity River, is approximately 21 kilometers (13 miles) in length and has a 254 square kilometer (98 square mile) drainage area. Reservoir releases from Benbrook Lake are joined by flows from Marys Creek, Walnut Creek, and several unnamed tributaries. Two USGS gaging stations are located 2.4 kilometers (1.5 miles) and 16.1 kilometers (10 miles) below the dam in Segment 0829. Available data from these two stations show that streamflow is largely regulated by releases from Benbrook Lake. The mean daily flow over the past 23 years (1952-1975) has been about 2.7 cubic meters per second (97 cfs). Figure F11 presents the flow frequency curve for the Fort Worth station (USGS 08047500) which is located 16 kilometers (10 miles) downstream from the dam. As indicated in the figure, the median flow (flow occurring 50 percent of the time) is 0.54 cubic meters per second (19 cfs). Obviously, the segment flow amounts to little more than a trickle much of the time.

The total drainage area of Clear Fork is about 1355 square kilometers (523 square miles). Since a large portion of this drainage area is controlled by Benbrook Reservoir, high streamflows are, for the most part, passed through the reservoir. In this regard, the streamflow quality is sensitive to the quality of the reservoir releases. In recent years, the drainage below the Benbrook Dam has experienced a rapid development and redevelopment for residential and industrial uses. Land use changes within the drainage area are expected to increase surface runoff (i.e., nonpoint source pollution) during a rainfall. Currently, no data are available for quantifying the nonpoint source pollution in the lower Clear Fork.

TABLE NO. XXVII

FISHES COLLECTED IN THE LOWER CLEAR FORK TRINITY RIVER
(SEGMENT 0829)
(TAKEN FROM KELLY 1975)

	STATION 1	STATION 2	STATION 3
Dorosoma cepedianum	R	R	R
Notemigenus chrysoleucas	R	R	R
Notropis lutrensis	R	O	A
Notropis venustus	R	R	R
Notropis umbratilis	F	A	O
Pimephales vigilax	R	R	O
Campostoma anomalum			R
Ictalurus natalis	R	R	
Ictalurus melas			R
Fundulus notatus	O	O	R
Gambusia affinis	A	A	R
Menidia audens	R		O
Micropterus salmoides	R	R	R
Lepomis gulosus	R		R
Lepomis cyanellus	R	R	R
Lepomis macrochirus	O	R	R
Lepomis microlophus	R	R	R
Lepomis auritus	R	R	R
Lepomis megalotis	R	R	O
Pomoxis annularis	R		
Percina caprodes	R		
No. of Collections	8	8	2
Total Specimens Collected	2420	1387	277

A - Abundant
F - Frequent
O - Occasional
R - Rare

Station 1 - Clear Fork, 0.9 km (0.6 miles) downstream from Benbrook Dam.
Station 2 - Clear Fork immediately below confluence with Marys Creek.
Station 3 - At Santa Fe railroad bridge between US 80 and confluence with the West Fork.

TABLE NO. XXVIII

FISHES COLLECTED IN THE LOWER CLEAR FORK
(SEGMENT 0829)
(TAKEN FROM TPWD 1957b)

Fish	No.	%
Gizzard shad	2	4.4
Blacktail shiner	2	4.4
Red shiner	3	6.7
Blackspot topminnow	12	26.7
Largemouth bass	1	2.2
Mosquitofish	25	55.6
TOTALS	45	100.0

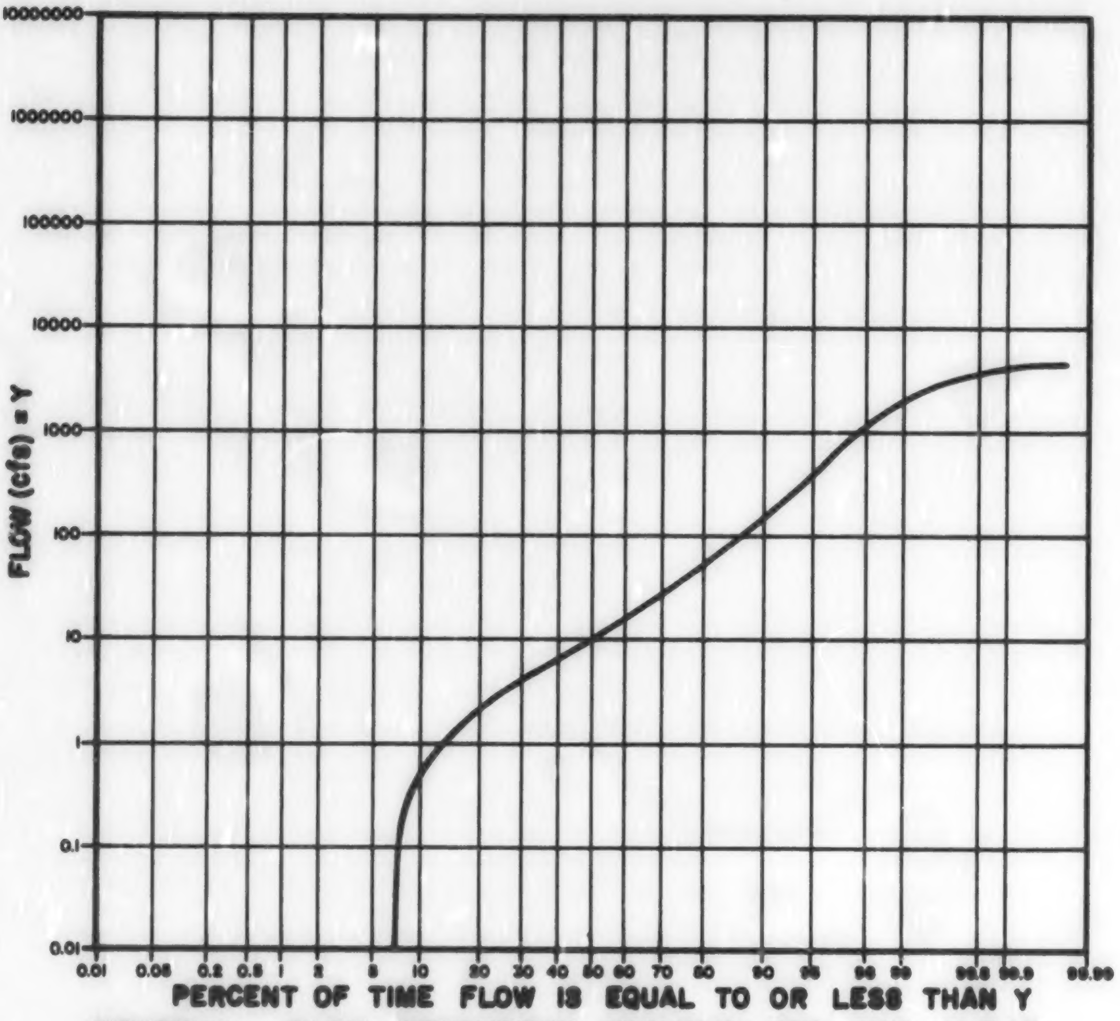


FIGURE F11. FLOW FREQUENCY ANALYSIS FOR THE CLEAR FORK TRINITY RIVER AT FORT WORTH (USGS 08047500). (DATA FROM USGS 1955-1971)

Available data from the City of Fort Worth reveal that water quality is generally good in the Clear Fork under low flow conditions. However, moderately high BOD and ammonia levels are occasionally detected in the segment. According to TWQB (1975-1976), there exist only one industrial and no domestic point sources within this watershed.

WATER USES

Domestic and Municipal

The Clear Fork from Benbrook Dam to the confluence with the Trinity River is not regularly used as a source of domestic and municipal water. During times of drought, water is released from Benbrook Lake and flows toward the City of Fort Worth where it is pumped out and used for domestic and municipal purposes. Water removal from this Segment by the City of Fort Worth is allowed by Certified Filing No. 757A, which allows withdrawal from both the Clear and West Forks of the Trinity River.

Industrial

The Clear Fork Trinity River is not used as a source of industrial water. According to TRA (1974a), no water rights permits have been issued which authorize the use of water from the Clear Fork for industrial purposes.

Agricultural

The Clear Fork Trinity River below Benbrook Lake is moderately used as a source of agricultural water. According to TRA (1974a) water rights permits for agricultural withdrawals from this segment total 4.44×10^5 cubic meters (360 acre-feet) per year.

Recreational

The Clear Fork Trinity River is heavily used as a source of recreation. Along the banks of the Clear Fork the City of Fort Worth has built areas such as city parks, a golf course, and several nature study areas. Activities associated directly with the river include fishing, canoeing, picnicking, hiking, and some swimming.

SUMMARY

Water quality in the Clear Fork is very good, particularly in the reach immediately below Benbrook Dam. All TWQB (1976a) criteria were met. Dissolved oxygen concentrations are consistently high, bacteria low, and nutrient concentrations moderate.

No tributary or sediment data were encountered, either for the recent or the historical period.

Historical data, where available, indicated a good degree of consistency with all parameters. Historical biological data were limited to data on fishes, which indicated both good numbers and diversity.

Additional Data Needs

Since Presentation Area F consists of three segments which differ from each other in several ways, their additional data needs are discussed separately as follows.

Regarding the Lower Clear Fork, available data are sufficient to determine some historical trends, and the continuation of current monitoring programs will show future trends. Though little or no data have been collected for the specific purpose of determining relative point and nonpoint loadings, point source discharges are few and small, and wet weather loadings can be predominantly attributed to nonpoint sources. However, data to distinguish between the various types of nonpoint sources and their loads in the segment are needed. A program to collect such data throughout the 208 designated planning area has been designed under the contract under which this report is prepared. The sampling is representative of the types of watersheds throughout the planning area, although no sampling sites specifically within the Lower Clear Fork watershed were chosen.

On the West Fork from Lake Worth Dam to Beach Street, additional data are needed to 1) determine, during low flow, all the sources of flow and pollutant loading, 2) determine the quality and quantity of rainfall runoff from subwatersheds tributary to the segment, and 3) determine the reponse of the segment to all the various inflows and conditions during periods of rainfall runoff. These data needs will be partly met by:

a) Continuous automated monitoring of dissolved oxygen, temperature, pH, conductivity, and flow on the West Fork at Beach Street, now being done by the USGS under contract with the North Central Texas Council of Governments as a part of the overall 208 Planning project, and to be continued with combined support of the USGS, the Texas Water Development Board, and local water agencies.

b) Sampling and analysis of the West Fork and selected tributary watersheds during rainfall runoff events, to be done under another portion of the contract under which this report is prepared.

c) Monitoring of pollutant sources and streamwater quality by the City of Fort Worth and other cities as required by state law (TWC 21.357, known as Senate Bill 835).

The West Fork from Beach Street to the Elm Fork confluence has considerable data available, as summarized above. However, additional data are needed to 1) determine diurnal variations in various parameters, including dissolved oxygen, pH, bacteria, and ammonia, which may be caused by diurnal variations in wastewater treatment plant discharges and/or photosynthesis, particularly during base flow conditions, 2) determine the chemical and physical characteristics of the black sediments which develop on the river bottom during low flow conditions and are resuspended during high flows, 3) determine the quality of rainfall runoff from subwatersheds which are tributary to the segment, 4) determine the quality and rate of discharges from wastewater treatment plants during periods of rainfall runoff and infiltration to collection systems, and 5) determine the response of the river to all inflows and conditions during rainfall runoff. As for the parameters which should be analyzed, the known and documented problems in the segment are directly related to dissolved oxygen and biochemical oxygen demand, fecal coliform bacteria, ammonia and other forms of nitrogen, phosphorous, suspended solids, algae, flow, and rainfall. Four types of data collection programs are required:

a) Continuous automated monitoring of dissolved oxygen, temperature, pH, and conductivity, along with flow, on the West Fork at Beach Street and at West Belt Line Road will directly satisfy some of the needs of (1) and (5), and indirectly some of the other needs, listed above. This monitoring is now being done by the USGS under contract with the North Central Texas Council of Governments as a part of the overall 208 Planning project, and is to be continued with combined support of the USGS, the Texas Water Development Board, and local water agencies.

b) Sampling and analysis of the West Fork and selected tributary watersheds during rainfall runoff events, to be done during 1977 under another portion of the contract under which this report is prepared, will address (3), (4), and (5), above.

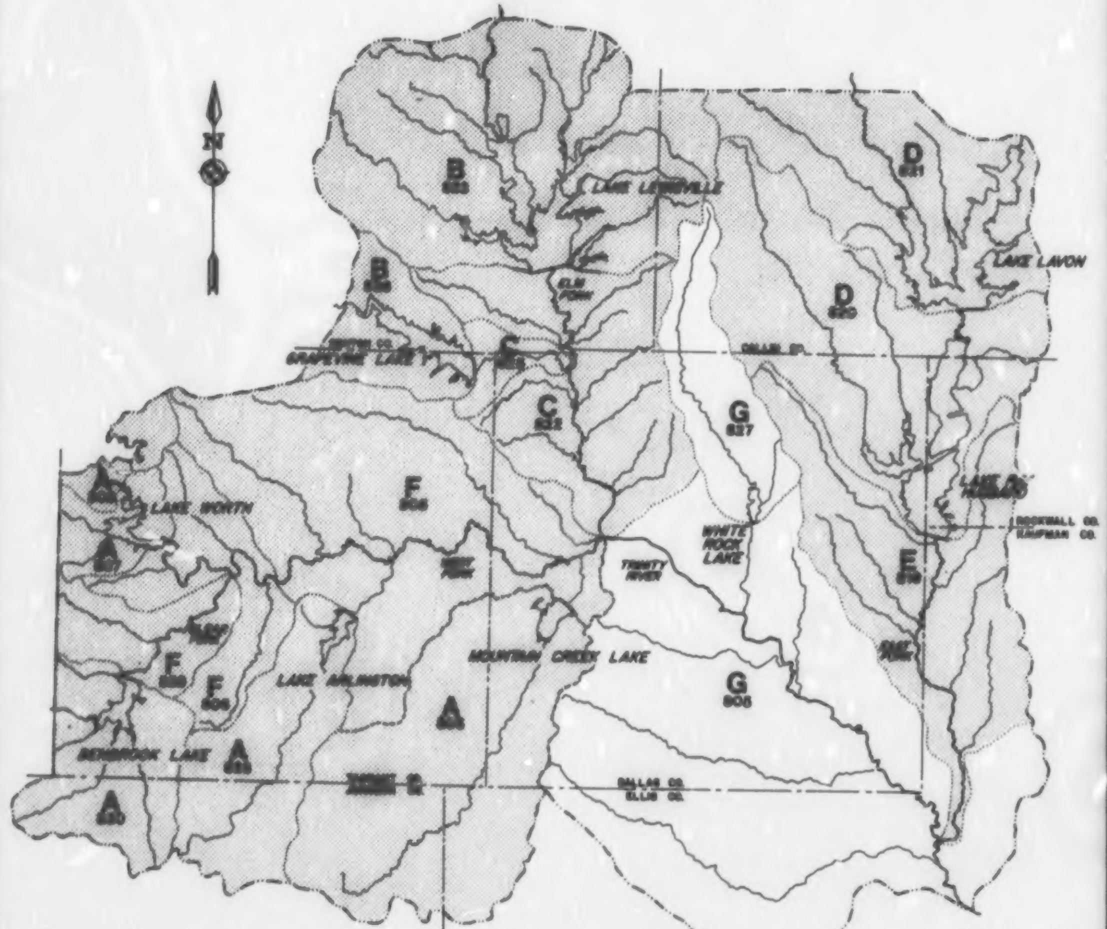
c) Frequent sampling and analysis of major point source discharges during rainfall runoff events, to be done at the same time as (b), above, will help to satisfy the same data needs.

d) Sampling and analysis of river bottom sludges and sediments during periods of low flow, to be done under a subsequent part of the contract under which this report is prepared, will address (2), above.

PRESENTATION AREA G

TRINITY RIVER

DALLAS/FORT WORTH DESIGNATED 208 PLANNING AREA
DELINEATION OF SEGMENTS AND PRESENTATION AREAS


N
B
B
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ELM FORK
GRAPEVINE LAKE
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LAKE LAVON
DALLAS CO.
G
827
A
LAKE WORTH
A
F
WEST FORK
WHITE ROCK LAKE
TRINITY RIVER
ROCKWALL CO.
KAUFMAN CO.
E
MOUNTAIN CREEK LAKE
LAKE ARLINGTON
F
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A
G
805
BENBROOK LAKE
A
A
DALLAS CO.
ELLIS CO.

PRESENTATION AREA G

SUMMARY

The Trinity River from the Elm Fork to SH 34 near Rosser contains water of poor quality. The primary factor affecting the quality of water in this portion of the Trinity River is the input from sewage treatment plants within the segment as well as plants upstream. Water within this segment characteristically has low dissolved oxygen concentrations and high nutrient, BOD, and coliform bacteria concentrations. Other parameters, such as pesticides and heavy metals, are measurable in this portion of the Trinity River.

White Rock Lake has water of considerably better quality. It does, however, exhibit numerous eutrophic symptoms, including occasional low dissolved oxygen concentrations, a significant summer stratification, and high concentrations of phytoplankton. Many more data were available for the Trinity River than White Rock Lake. Consequently, it is easier to assess the water quality in that segment.

Biological data were largely limited to historical analyses. In the case of the Trinity River, biological data indicated a high degree of stress directly related to the level of pollution encountered there. Historical biological data for the Trinity River were predominantly related to phytoplankton and macroinvertebrates. Biological data on White Rock Lake indicated that the lake has a diverse biotic community.

MONITORING STATIONS

Agency	Location	Station Number	Type of Record*
Segment 0805			
DAL	TR at Westmoreland	9	A
DAL	TR at Corinth Street	10	B
DAL	Dallas White Rock Plants Combined Effluents	11	B
DAL	White Rock Creek at Hawn Freeway	12	A
DAL	TR at South Loop 12	13	B
DAL	Five Mile Creek at US 75	14	A
DAL	TR at Malloy Bridge Road	15	A
DAL	Ten Mile Creek at Parkinson Road	16	A
DAL	TR at Dowdy Ferry Road	18	A
DAL	TR at South Belt Line Road	19	A
DAL	TR at SH 34	20	A
TDHR	SH 34 near Rosser	-	-
TWQB	Trinity River at SH 34 Southwest of Rosser	0805.01	CaCcBaBcMbS
TWQB	TR at Belt Line Rd. East of Wilmer	0805.02	CaCc

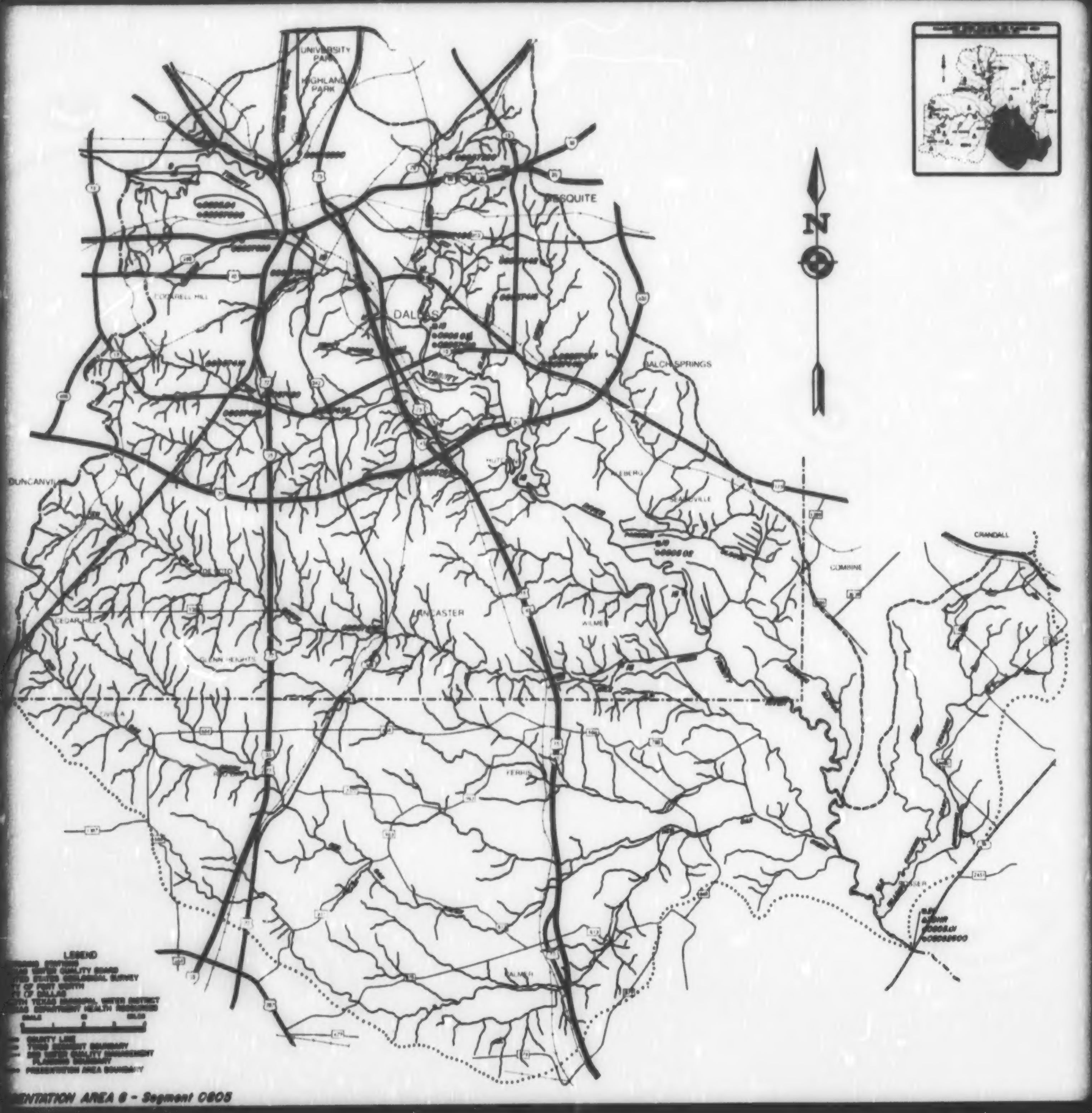
continued. . .

Agency	Location	Station Number	Type of Record*
TWQB	TR as South Loop 12 South of Dallas	0805.03	CbBaBbBcMaS
TWQB	TR as Commerce Street in Dallas	0805.04	CaCc
USGS	Ash Creek at Highland Road, Dallas	08057320	H
USGS	White Rock Creek at Scyene Road at Dallas	08057400	Dd
USGS	Trinity River below Dallas	08057410	DdQOpPSp
USGS	Elam Creek at Seco Boulevard, Dallas	08057415	H
USGS	Fivemile Creek at Kiest Boulevard, Dallas	08057418	H
USGS	Fivemile Creek at U.S. Highway 77, Dallas	08057420	H
USGS	Woody Branch at U.S. Highway 77, Dallas	08057425	H
USGS	Fivemile Creek at Lancaster Road, Dallas	08057430	H
USGS	Newton Creek at IH 635, Dallas	08057435	H
USGS	Whites Branch at IH 635, Dallas	08057440	H
USGS	Prairie Creek at Jennie Lee Street, Dallas	08057442	H
USGS	Prairie Creek at U.S. Highway 175, Dallas	08057445	Dd
USGS	Hattfields Branch at Seagoville Road, Dallas	08057447	H
USGS	Tenmile Creek at State Highway 342 at Lancaster	08057450	Dd
USGS	Turtle Creek at Dallas	08056500	Dd
USGS	Trinity River at Dallas	08057000	Dd
USGS	Coombs Creek at Sylvan Avenue, Dallas	08057020	H
USGS	Cedar Creek at Bonnie View Road, Dallas	08057050	H
USGS	Trinity River near Rosser SH 34	08062500	DdQOpP

Segment 0827

Agency	Location	Station Number	Type of Record*
TWQB	White Rock Lake at Midlake near Dam	08027.01	Cc
USGS	White Rock Creek at Keller Springs Road at Dallas	08057100	Dd
USGS	Rush Branch at Arapaho Road, Dallas	08057130	H
USGS	Cottonwood Creek at Forest Lane, Dallas	08057140	H
USGS	Floyd Branch at Forest Lane, Dallas	08057160	H
USGS	White Rock Creek at Greenville Avenue, Dallas	08057200	Dd

*The "Type of Record" designations for each Agency are explained under Appendix A, Source of Information.


UNIVERSITY PARK
HIGHLAND PARK
MESQUITE
COCKRELL HILL
DALLAS
TRINITY
BALCH SPRINGS
HUTCHINS
SEAGOVILLE
DUNCANVIL
DE SOTO
CEDAR HILL
LANCASTER
WILMER
GLENN HEIGHTS
COMBINE
CRANDALL
OVILLA
FERRIS
ROSSER
PALMER
N
LEGEND
COUNTY LINE
PRESENTATION AREA BOUNDARY
ENTATION AREA 6 - Segment 0805

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE G1

TRINITY RIVER FROM CONFLUENCE WITH THE ELM FORK TO SH 34 NEAR ROSSER - Segment 0805, Presentation Area G

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - Presentation Area G, West Fork Trinity River from confluence with the Elm Fork Trinity River to SH 34 near Rosser (DAL 9, 10, 13, 15, 18, 19, 20; TRA; TWQB 0805.01, 0805.02, 0805.03, 0805.04, 0805.05; USGS 08057410, 08062500; TDHR). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Max	Min	S	N
Temperature (C)	19.0	30.0	2.8	6.0	281
Dissolved Oxygen	3.4	11.9	0.0	**	279
pH (pH units)	7.4	8.5	6.9	0.3	285
Conductivity (umhos/cm)	737	1500	160	274	276
Total Suspended Solids	152	2183	16	**	103
Volatile Suspended Solids	39	290	0	**	90
Total Dissolved Solids	490	690	198	142	157
Ammonia, as N	12.8	16.0	0	5.1	78
Nitrite, as N	0.17	0.62	0.00	**	47
Nitrate, as N	0.77	3.95	0.00	**	80
Organic Nitrogen, as N	3.0	8.0	0.0	**	61
Total Kjeldahl Nitrogen, as N	7.4	23.0	1.0	**	37
Total Phosphate, as P	4.04	18.00	0.00	**	93
Orthophosphate, as P	10.0	31.3	0.2	**	102
Chloride, as Cl	78	360	1	**	185
Sulfate, as SO_4	86	147	29	33	127
Total Alkalinity, as $CaCO_3$	228	292	114	40	11
Bicarbonate, as HCO_3	209	284	134	51	38
Carbonate, as CO_3	0	0	0	0	38
Carbonate Hardness, as $CaCO_3$	157	190	120	14	38
Noncarbonate Hardness, as $CaCO_3$	9	43	0	**	38
Chlorophyll *a* (ug/l)	34	182	1	**	27
Fecal Coliform (#/100 ml)	27900*	1.52×10^6	0	**	54
Total Coliform (#/100 ml)	2.1×10^6	2.4×10^7	2300	**	61
Color (Pt-Co units)	37	140	5	**	36
Turbidity (JTU)	44	250	6	**	60
Biochemical Oxygen Demand$_5$	21.6	40.0	1.9	8.7	125
Total Organic Carbon	23.0	49.0	4.2	2	97
Phenols (ug/l)	11	59	1	**	36
Methylene-Blue-Active Sub.	0.6	2.2	0	**	37
Silica, as SiO_2	8.2	16	3.8	3.4	38
Calcium, as Ca	53	64	42	5	31
Magnesium, as Mg	5.7	7.8	3.4	1.4	38
Sodium, as Na	69	140	20	**	38
Potassium, as K	9.3	19.0	3.9	4.5	38
Sodium Absorption Ratio, SAR	2.4	4.9	0.8	**	38
Fluoride, as F	1.0	2.6	0.3	**	31

continued. . .

Parameter	Mean	Max	Min	S	N
Aluminum, as Al (ug/l)	40	200	0	**	12
Arsenic, as As (ug/l)	5	7	0	**	12
Boron, as B (ug/l)	244	500	70	**	12
Cadmium, dissolved (ug/l)	2	4	0	**	14
Cadmium, total (ug/l)	5	7	4	1	7
Chromium, dissolved (ug/l)	5	25	0	**	14
Chromium, total (ug/l)	30	60	0	**	7
Cobalt, dissolved (ug/l)	1	2	0	1	12
Copper, dissolved (ug/l)	14	56	1	**	12
Copper, total (ug/l)	143	260	40	**	7
Iron, dissolved (ug/l)	72	250	0	**	12
Iron, total (ug/l)	1945	9800	100	**	7
Lead, dissolved (ug/l)	3	10	0	**	14
Lead, total (ug/l)	31	60	0	**	7
Lithium, dissolved (ug/l)	7	10	0	**	12
Manganese, dissolved (ug/l)	43	140	0	**	12
Manganese, total (ug/l)	120	260	30	**	7
Mercury, dissolved (ug/l)	0.1	0.6	0.0	**	14
Mercury, total (ug/l)	58	200	0	**	7
Nickel, dissolved (ug/l)	37	100	0	**	7
Selenium, total (ug/l)	6	16	2	**	6
Silver, total (ug/l)	6	23	0	**	7
Strontium, dissolved (ug/l)	439	540	290	71	12
Zinc, dissolved (ug/l)	22	50.	0	**	12
Zinc, total (ug/l)	128	271	0	**	7
Aldrin, total (ug/l)	0.00	0.00	0.00	0.0	12
DDD, total (ug/l)	0.00	0.00	0.00	0.0	12
DDE, total (ug/l)	0.00	0.00	0.00	0.0	12
DDT, total (ug/l)	0.00	0.00	0.00	0.0	12
Dieldrin, total (ug/l)	0.02	0.04	0.00	**	12
Endrin, total (ug/l)	0.00	0.00	0.00	0.0	12
Heptachlor, total (ug/l)	0.00	0.00	0.00	0.0	10
Heptachlor Epoxide, total (ug/l)	0.00	0.03	0.00	0.01	13
Lindane, total (ug/l)	0.01	0.09	0.00	**	14
Chlordane, total (ug/l)	0.1	0.3	0.0	**	12
PCB's, total (ug/l)	0.00	0.00	0.00	0.0	14
Diazinon, total (ug/l)	0.24	0.75	0.00	**	12
Malathion, total (ug/l)	0.01	0.08	0.00	**	14
Methoxychlor, total (ug/l)	0.00	0.00	0.00	0.0	2
Methyl Parathion, total (ug/l)	0.00	0.00	0.00	0.0	12
Parathion, total (ug/l)	0.00	0.00	0.00	0.0	12
2, 4-D, total (ug/l)	0.40	4.20	0.00	**	14
2, 4, 5-T, total (ug/l)	0.00	0.00	0.00	0.0	2
Silvex, total (ug/l)	0.00	0.00	0.00	0.0	14

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in the Main Stem Trinity River (Segment 0805) were taken from TWQB (1976a).

Temperature - Not to exceed 35.0 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 2.0 mg/l. Criterion not met. The concentration was below 2.0 mg/l much of the time, and several values of 0.0 mg/l were reported.
pH - Acceptable range 6.5-8.5. Criterion met.
Total Dissolved Solids - Mean concentration not to exceed 850 mg/l. Criterion met.
Chloride - Mean concentration not to exceed 175 mg/l. Criterion met.
Sulfate - Mean concentration not to exceed 175 mg/l. Criterion met.
Fecal Coliform - Log. mean not to exceed 2000 organisms/100 ml. Criterion not met. The reported log. mean fecal coliform concentration was 27,900 organisms/100 ml. This is greatly in excess of the TWQB (1976a) standard of 2000 organisms/100 ml. Moreover, there were numerous 30-day periods with at least five observations producing a log. mean in excess of 2000 organisms/100 ml. This corresponds to the exact specifications of TWQB (1976a) for determining fecal coliform violations.

Many parameters exhibit a great similarity between the two Segment 0805 presentation areas. Dissolved oxygen values produced a lower mean in Presentation Area G and contained more 0.0 mg/l values. Fecal coliform counts were much higher in Presentation Area G, exceeding the TWQB (1976a) standard significantly. In addition, many parameters such as ammonia, nitrate, orthophosphate, chloride, chlorophyll a, and BOD appeared to be substantially greater in concentration in Presentation Area G. All of this is largely due to the great volume of treated sewage effluent carried by the Trinity River.

Figure G2 presents river mile profiles in Segment 0805, Presentation Area G, for the parameters dissolved oxygen, chloride, and conductivity. It may be noticed that the mean dissolved oxygen concentration is less than 5.0 mg/l for the entire reach and values of 0.0 mg/l were reported for each station. Both conductivity and chloride show decreasing trends for the reach.

Tributary Water Analyses - The tributaries entering the Trinity River in Segment 0805, Presentation Area G, include Turtle Creek, Coombs Creek, Cedar Creek, White Rock Creek, Honey Springs Branch, Elam Creek, Five Mile Creek, Prairie Creek, Ten Mile Creek, the East Fork Trinity River, and Red Oak Creek. Of these eleven tributaries, three are monitored by the USGS. They are Turtle Creek (USGS 080506500), White Rock Creek (USGS 08057100, 08057200, 08057300, 08057400), and Ten Mile Creek (USGS 08057450). Unfortunately, the data provided on these tributaries are discharge measurements and do not reveal any information about water quality. The East Fork is monitored by the NTMWD, the USGS, and the TWQB. The results of their findings can be found in the section on Segment 0819. The City of Dallas monitors Five Mile, Ten Mile and White Rock Creeks. The following table presents the recent data that are available from the various sampling agencies. All concentrations are in mg/l, unless otherwise specified.

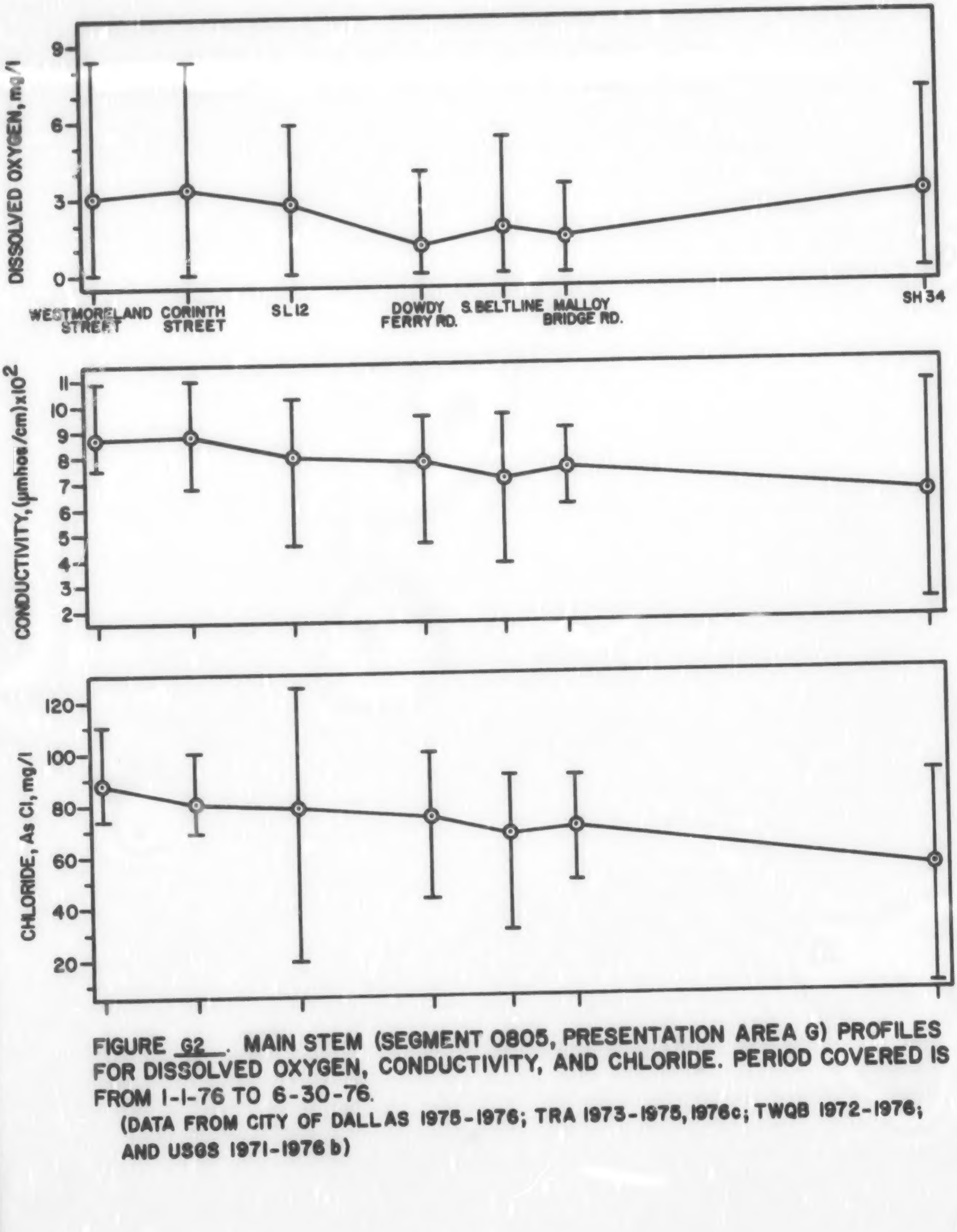


FIGURE G2 . MAIN STEM (SEGMENT 0805, PRESENTATION AREA G) PROFILES FOR DISSOLVED OXYGEN, CONDUCTIVITY, AND CHLORIDE. PERIOD COVERED IS FROM 1-1-76 TO 6-30-76.

(DATA FROM CITY OF DALLAS 1975-1976; TRA 1973-1975, 1976c; TWQB 1972-1976; AND USGS 1971-1976 b)

Water Quality of
Five Mile Creek (DAL 29; TRA)
(10-1-74 through 6-30-76)

Parameter	Mean	Max	Min	S	N
Temperature (C)	15.5	25.0	2.8	4.2	16
Dissolved Oxygen	7.8	11.2	3.4	1.7	15
pH (pH units)	7.6	8.0	7.2	0.2	15
Conductivity (umhos/cm)	490	670	304	94	16
Total Dissolved Solids	270	270	270	-	1
Total Suspended Solids	64	64	64	-	1
Ammonia, as N	0.0	0.0	0.0	-	1
Nitrite + Nitrate, as N	0.05	0.05	0.05	-	1
Organic Nitrogen, as N	1.7	1.7	1.7	-	1
Total Phosphate, as P	2.6	2.6	2.6	-	1
Orthophosphate, as P	0.24	0.90	0.00	**	10
Chloride, as Cl	30	69	18	14	15
Fecal Coliform (#/100 ml)	1000	1000	1000	-	1
Total Coliform (#/100 ml)	59000	2.4×10^5	400	**	9
Biochemical Oxygen Demand$_5$	1.9	1.9	1.9	-	1
Turbidity (JTU)	26	82	3	**	10
Chlorophyll *a* (ug/l)	35	35	35	-	1

-Standard deviation not computed when N is less than six.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality of
Ten Mile Creek (DAL 33; TRA)
(10-1-74 through 6-30-76)

Parameter	Mean	Max	Min	S	N
Temperature (C)	17.2	25.0	8.9	4.1	18
Dissolved Oxygen	6.3	11.0	2.2	1.7	18
pH (pH units)	7.7	7.9	7.1	0.2	18
Conductivity (umhos/cm)	718	1180	482	194	18
Total Dissolved Solids	677	677	677	-	1
Total Suspended Solids	27	27	27	-	1
Ammonia, as N	1.1	1.1	1.1	-	1
Nitrite + Nitrate, as N	12.0	12.0	12.0	-	1
Organic Nitrogen, as N	2.0	2.0	2.0	-	1
Total Phosphate, as P	7.9	7.9	7.9	-	1
Orthophosphate, as P	17.0	44.0	0.1	**	10
Chloride, as Cl	54	73	24	11	18
Fecal Coliform (#/100 ml)	125	500	0	-	4
Total Coliform (#/100 ml)	41000	1.5×10^5	400	**	10
Biochemical Oxygen Demand$_5$	6.9	6.9	6.9	-	1
Turbidity (JTU)	31	98	5	**	10
Chlorophyll *a* (ug/l)	3	3	3	-	1

-Standard deviation not computed when N is less than six.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality of
White Rock Creek (DAL 27)
(10-1-74 through 6-30-76)

Parameter	Mean	Max	Min	S	N
Temperature (C)	18.2	24.0	7.5	3.4	7
Dissolved Oxygen	6.2	10.2	3.8	2.0	7
pH (pH units)	7.7	8.0	7.5	0.2	7
Conductivity (umhos/cm)	578	726	458	62	7
Orthophosphate, as P	0.21	0.30	0.10	0.6	7
Chloride, as Cl	51	134	24	**	7
Total Coliform (#/100 ml)	11000	2.4×10^4	30	**	6
Turbidity (JTU)	24	47	4	**	7

**Data from a clearly non-normal distribution; no standard deviation computed.

Sediment Analyses - The following table summarizes recent sediment analyses conducted on the Trinity River between the Elm Fork confluence and SH 34 near Rosser. All concentrations are in mg/kg (dry weight), unless otherwise specified. (Data from TWQB 0805.01, 0805.03; USGS 08057410, 08062500.)

Parameter	Mean	Max	Min	S	N
Oil and Grease	809	923	695	-	2
Phosphorus in Particulates	700	750	650	-	2
Kjeldahl Nitrogen, as N	427	427	427	-	1
Arsenic, as As	0.12	0.23	0.00	-	2
Barium, as Ba	637	1121	153	-	2
Boron, as B	20.3	20.9	19.7	-	2
Cadmium, as Cd	2.44	2.87	2.01	-	2
Chromium, as Cr	36.9	43.9	29.8	-	2
Copper, as Cu	52.5	62.7	42.2	-	2
Lead, as Pb	35.5	37.3	33.6	-	2
Manganese, as Mn	158	206	110	-	2
Mercury, as Hg (mg/kg, wet wt.)	0.1	0.1	0.1	-	2
Nickel, as Ni	14.2	14.7	13.7	-	2
Selenium, as Se	1.90	3.03	0.77	-	2
Silver, as Ag	1.5	1.8	1.2	-	2
Zinc, as Zn	76.1	84.7	67.5	-	2
Aldrin (ug/kg)	0	0	0	0	14
Chlordane (ug/kg)	93	610	0	**	11
DDD (ug/kg)	1.6	6.7	0.0	**	11
DDE (ug/kg)	4.2	15	0	**	11
DDT (ug/kg)	0.13	1.20	0.00	**	11
Diazinon (ug/kg)	0	0	0	-	2
Dieldrin (ug/kg)	10.6	54	0.1	**	11
Endrin (ug/kg)	0	0	0	0	11
Heptachlor (ug/kg)	0.3	3.0	0	**	12
Heptachlor Expoxide (ug/kg)	1.6	16	0	**	11
Lindane (ug/kg)	0	0	0	0	11
Methoxychlor (ug/kg)	0	0	0	-	2

continued. . .

Parameter	Mean	Max	Min	S	N
Methyl Parathion (ug/kg)	0	0	0	-	2
Parathion (ug/kg)	0	0	0	-	2
PCB's (ug/kg)	27	86	0	**	11
Silvex (ug/kg)	0	0	0	-	2
Toxaphene (ug/kg)	0	0	0	-	2

-Standard deviation not computed when N is less than six.
**Data from a clearly non-normal distribution; no standard deviation computed.

Biological
(10-1-74 through 6-30-76)

Bacteria - According to recent available data, the Trinity River between the confluence with the Elm Fork and SH 34 near Rosser has a significantly greater concentration of fecal coliform organisms than the West Fork from Beach Street to the confluence with the Elm Fork. The log. mean fecal coliform count for the Trinity River from the Elm Fork to SH 34 Rosser was 27,900 organisms/100 ml (n=54). The maximum count reported was 1,520,000 organisms/100 ml. The relatively higher fecal coliform counts in this portion of the river are due to a number of factors, including additional input from sewage treatment plants in the segment and the East Fork, as well as bacterial regrowth from input upstream.

Total coliform data produced a mean value of 2,100,000 organisms/100 ml and a maximum value of 24,000,000 organisms/100 ml.

Plankton - Plankton counts and identifications are almost entirely lacking for the Trinity River for the recent period. Table No. XXIX presents phytoplankton recorded for SH 34 near Rosser on January 10, 1976. Most of the organisms encountered are pollution-tolerant, according to Palmer (1969).

No other recent biological data were encountered for the Trinity River from the Elm Fork to SH 34 near Rosser.

HISTORICAL WATER QUALITY AND TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - Historical data on the Trinity River are quite abundant for a number of parameters. However, analysis of historical water quality trends in the Trinity River from the confluence with the Elm Fork to SH 34 near Rosser is complicated by 1) the strong relationships many parameters show with flow and 2) the high variation in flow exhibited by this portion of the Trinity River. In addition, laboratory

TABLE NO. XXIX

PHYTOPLANKTON REPORTED FOR SH 34 NEAR ROSSER (SEGMENT 0805) ON JANUARY 10, 1976

(Taken from TRA 1976c)

Organism	Abundance
Tetraedron sp.	r
Chlorella sp.	f - o
Misc. Ciliata	a
Stephanodiscus sp.	r
Melosira sp.	o
Selenastrum sp.	o - r
Synedra sp	r
Misc. Bacillariophyceae	f
Crucigenia sp.	r
Ankistrodesmus sp.	o
Phacus sp.	r
Gomphonema (*parvulum*)	o

a = abundant
f = frequent
o = occasional
r = rare

and field methods have changed substantially over the years. Notwithstanding these difficulties, one may compare present river conditions to general (and often subjective) assessments made in the past.

The Texas Health Department (1925) conducted an extensive survey of the main stem Trinity River. The survey included bacteriological and water chemistry analyses, interviews, and visual assessments. According to THD (1925),

> The flow below Dallas for many miles does not impress one as being that of a river. A stench from its inky surface putrescent with the oxidizing processes to which the shadows of overarching trees add Stygian blackness and the suggestion of some mythological river of death. With this burden of filth the purifying agencies of the stream are prostrated; it lodges against obstructions in the stream and rots, becoming hatcheries of mosquitoes and malaria. A thing of beauty is thus transformed into one of hideous danger.

Apparently, conditions in the river were worse 50 years ago. This was due primarily to sewage effluent from overloaded sewage treatment plants, as well as packing house waste coming largely from the Fort Worth area. During a two-month period in the summer of 1924, Dallas had 71 reported cases (eight deaths) of typhoid. This represented the greatest typhoid rate in the state and followed an eight month period of bypassing raw sewage while treatment plants were being upgraded. Since that time, pollution controls and improved sewage treatment have resulted in improved conditions in the Trinity River.

Approximately 18 sites were utilized in the Trinity River from the Elm Fork to SH 34 near Rosser by THD (1925). Chemical analyses conducted included dissolved oxygen, temperature, ammonia, nitrite, nitrate, solids, and alkalinity. Dissolved oxygen data produced a mean of 1.6 mg/l and a maximum and minimum of 7.3 mg/l and 0.0 mg/l respectively (n=26). This is even lower than the DO concentration reported by THD (1925) for the West Fork. Concentrations of dissolved oxygen this low represent a severe stress situation for aquatic organisms in this reach of the river. Little can be said about other parameters, due to lack of information concerning methods and reporting units. The river did, however, contain a substantial amount of free ammonia, but little nitrite or nitrate. This is reflective of the sewage effluent carried by the river.

TDH (1959) reported the results of a similar study in which 33 stations were sampled along the Trinity River from Fort Worth to Rosser. It was determined that there were times when the water exhibited a low biochemical oxygen demand, but in general, the water in the main stem above Rosser, Texas had the quality of weak sewage. The mean dissolved oxygen concentration for the Trinity River from the Elm Fork confluence to SH 34 near Rosser, according to this study, was 2.3 mg/l (n=231). The maximum and minimum concentrations were, respectively, 9.6 mg/l and 0.0 mg/l. These values are between those reported by TDH (1925) and those in the WATER ANALYSES table.

Goff (1961) reported that the Trinity River in southern Dallas County exhibited a slight decrease in water quality from 1949 to 1959. This portion of the river was characterized as being of poor organic quality and often anaerobic.

Historical trends in total dissolved solids are presented for the period 1960-1975 in Figure G3. Total dissolved solids computations utilizing time-weighted averages are consistently higher than those of discharge-weighted averages. Figure G3 reveals no clear trend in the chemical quality of the water, but it does show that the higher streamflows generally contain the lower concentrations of dissolved solids. In other words, the chemical quality of the water appears to be virtually independent of chronology, but it has a close inverse relationship with streamflow.

Historical data on sulfate and chloride show the same relationship with flow as total dissolved solids (Figure G4). The higher streamflows result in lower concentrations of these two ions, and vice versa. From the results of regression analyses, several other parameters have been found to exhibit strong inverse relationships with streamflow. These parameters include sodium, magnesium, and specific conductance. Regression curves for the Rosser station reveal that the dissolved solids curve is almost parallel to that of specific conductance. Dissolved solids (in mg/l) can be effectively approximated as 60 percent of the specific conductance (in micromhos). Figures G5 and G6 present log-log plots for chloride and sulfate, respectively, versus specific conductance. A strong log-log "linear" relationship is found for these ions within the range of specific conductance 350-1000 micromhos. Through the determination of specific conductance, the aforementioned relationships provide a practical way of inferring general water quality at the Rosser station. These relationships may be used as a basis for extrapolating concentrations of dissolved solids, chloride, and sulfate in the Trinity River from the Elm Fork to SH 34 near Rosser.

Chemical quality in terms of major cations and anions (in milliequivalents per liter) are also compared between base flow and high flow conditions (Figure G7). A distinctive pattern is revealed, showing differences in chemical quality between the two flow regimes within the segment. The total ionic contents under base flow conditions, ranging from 8.07 to 10.7 meq/l at the various stations, are at least two times greater than those of the high flow conditions. Again, in Figure G7, chemical quality indicates a high degree of similarity among stations under each flow regime.

Tributary Water Analyses - Tributary analyses for Segment 0805, Presentation Area G are available for Five Mile Creek and Lower White Rock Creek. Similar to tributaries in Presentation Area F, data for these tributaries are not sufficient enough to develop trends with time.

Sediment Analyses - Historical sludge analyses in the Trinity River have been conducted by TRA (1972-1976). Table No. XXX presents the results of these two sampling endeavors for the stations at Commerce Street, South Loop 12, Dowdy Ferry Road, and SH 34 near Rosser. Both sampling efforts were conducted under low flow conditions. The South Loop 12 station, about four miles downstream from the Dallas Central STP

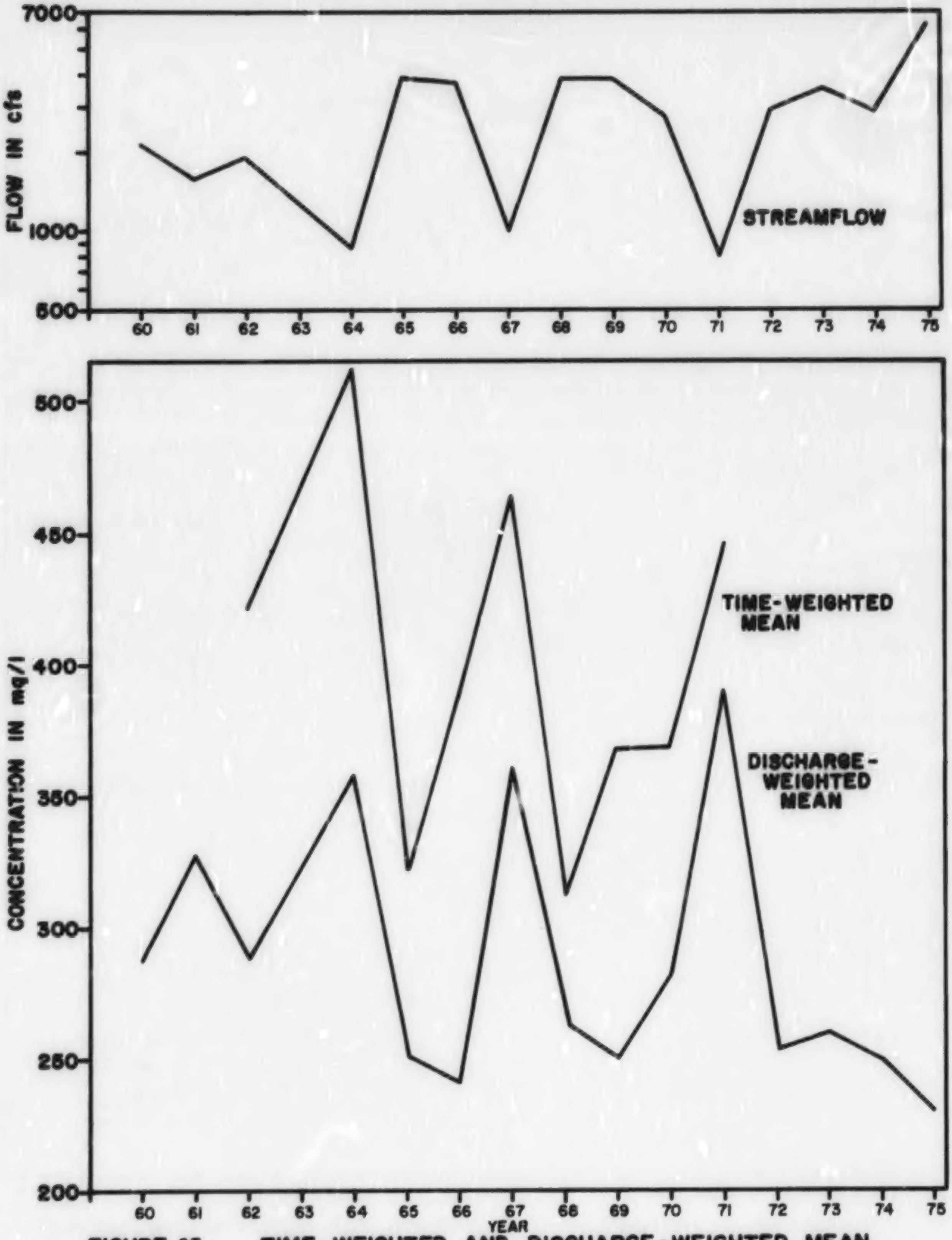


FIGURE G3. TIME-WEIGHTED AND DISCHARGE-WEIGHTED MEAN CONCENTRATIONS FOR TOTAL DISSOLVED SOLIDS AT SH 34 NEAR ROSSER (Segment 0805).
(DATA FROM USGS 1960-1976)

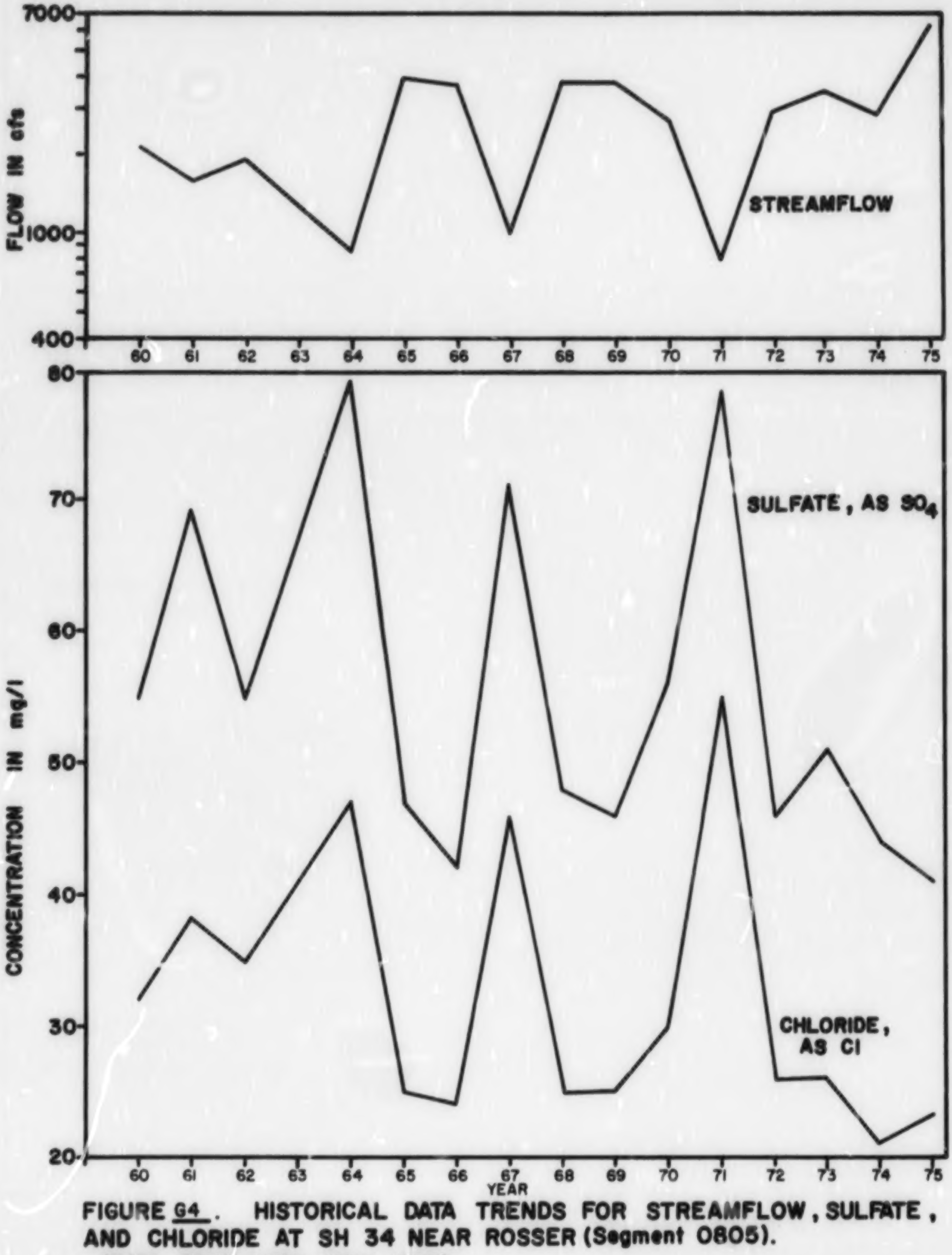


FIGURE 64. HISTORICAL DATA TRENDS FOR STREAMFLOW, SULFATE, AND CHLORIDE AT SH 34 NEAR ROSSER (Segment 0805).
(DATA FROM USGS 1960-1976)

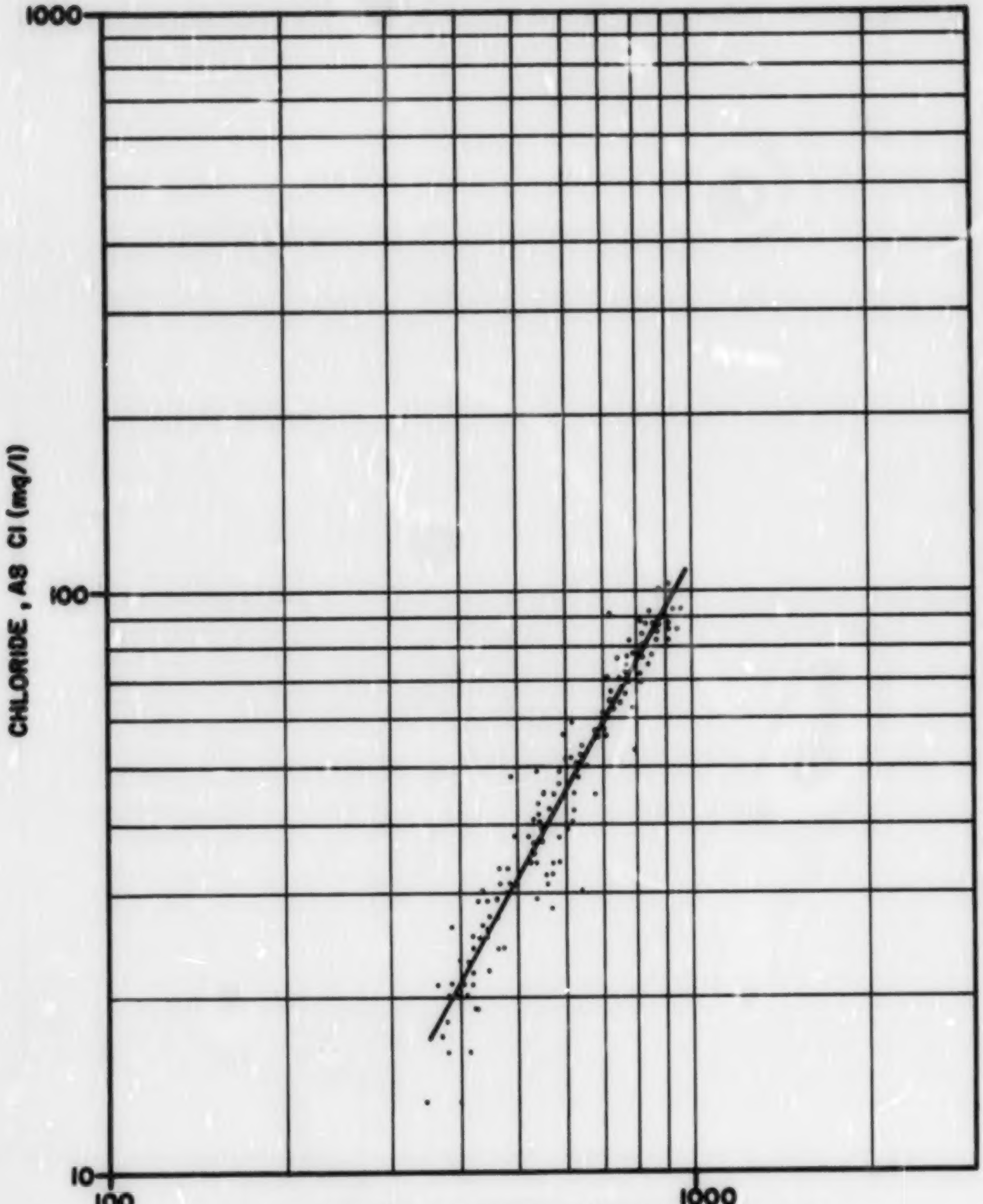


FIGURE 65 . CHLORIDE ION CONCENTRATION vs. SPECIFIC CONDUCTANCE AT SH 34 NEAR ROSSER.
(DATA FROM USGS 1967-1972)

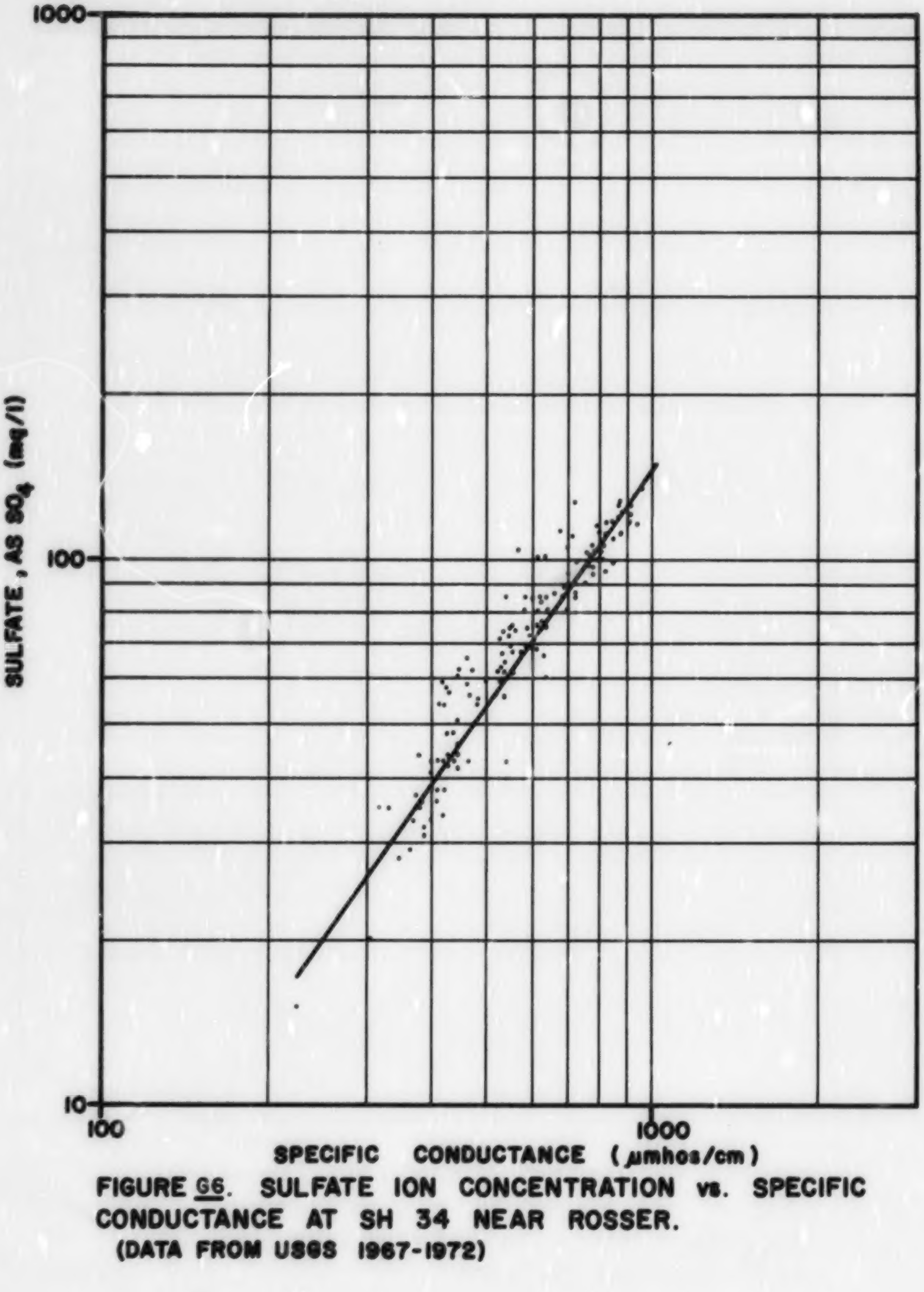


FIGURE G6. SULFATE ION CONCENTRATION vs. SPECIFIC CONDUCTANCE AT SH 34 NEAR ROSSER.
(DATA FROM USGS 1967-1972)

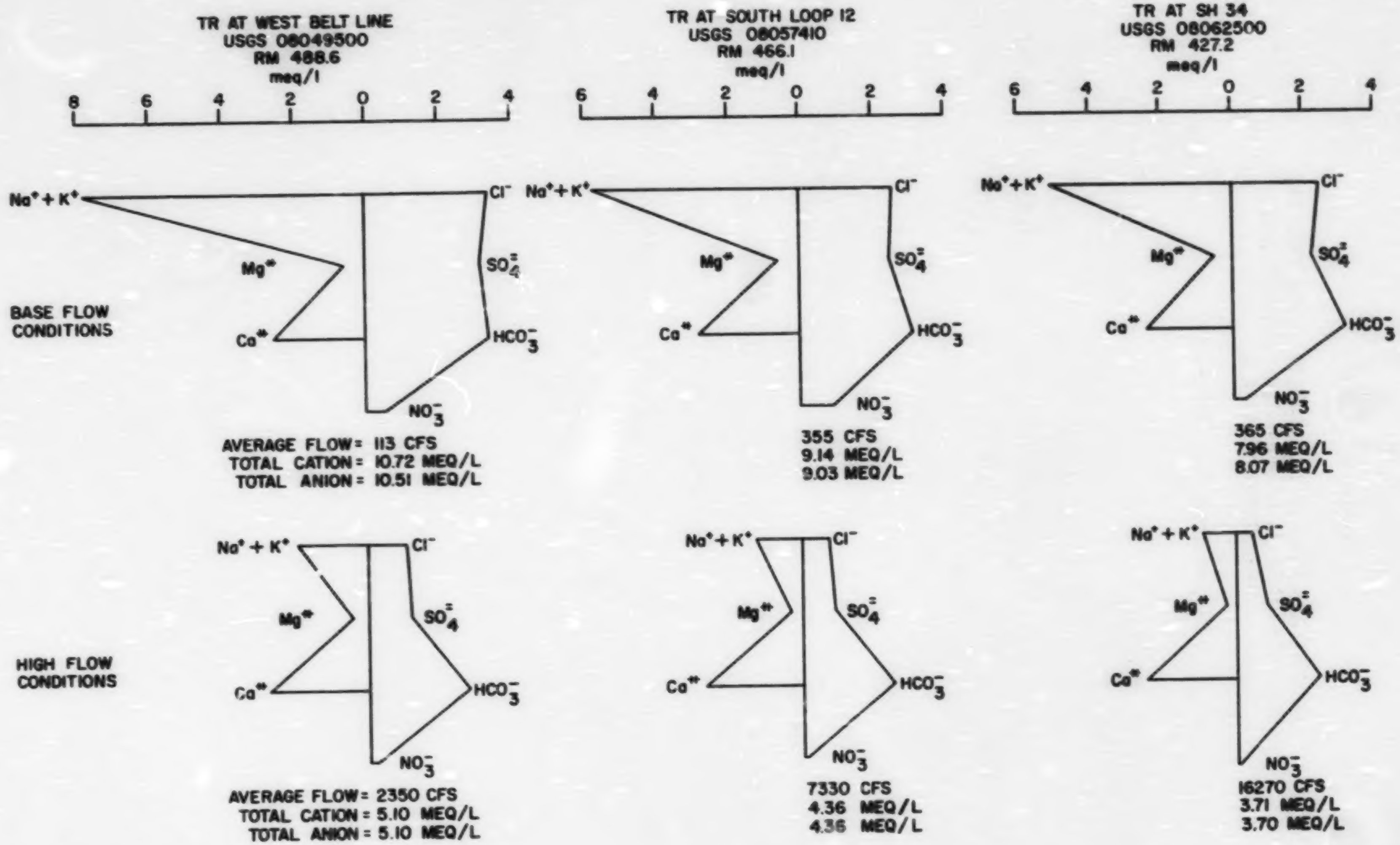


FIGURE 67. A COMPARISON OF MAJOR ION CONCENTRATIONS AT HIGH AND LOW FLOW IN SEGMENT 0805.
(DATA FROM USGS 1967-1972)

TABLE NO. XXX

SEDIMENT ANALYSES IN THE TRINITY RIVER FROM THE ELM FORK TO SH 34 NEAR ROSSER (SEGMENT 0805, PRESENTATION AREA G)

(Taken from TRA 1972-1976)

Parameter (Mean Values) mg/kg (dry weight)	Station			
	Commerce Street	S. Loop 12	Dowdy Ferry	SH 34 Near Rosser
River Mile	474.6	466.1	458.0	427.2
Ammonia, as N		735		
Nitrate, as N		25.3		
Organic Nitrogen, as N		3,688		
Orthophosphate, as P		1,270		
Total Phosphate, as P		2,400		
BOD_5	12,300	42,820	15,300	915
BOD_{20}			124,000	11,140

outfall, had the highest BOD_5 value of all stations. In general, values indicate a large amount of nutrient and oxygen-demanding material in the sediments of this portion of the Trinity River. Upon resuspension, this would constitute a significant nonpoint source of these constituents to the river.

Biological
(Prior to 10-1-74)

Bacteria - Historical trends in total and fecal coliform bacteria at SH 34 near Rosser are presented in Figure G8. The fecal coliform values in particular appear to show the effect of wastewater chlorination, as initiated by the Cities of Dallas and Fort Worth around 1970. Values appear to show a great deal of fluctuation over a given period of time. As one may see, fecal coliform concentrations have posed a problem for this reach of the river for a number of years.

Data for the years 1972 and 1973 from TRA (1972-1976) produced a log. mean fecal count of 1010 organisms/100 ml (n=15). However, during one thirty-day period, the log. mean was 3000 organisms/100 ml (n=7). This exceeds the current standard of 2000 organisms/100 ml (TWQB 1976a). The mean total coliform count reported for 1972 and 1973 by TRA (1972-1976) was 49,000 organisms/100 ml (n=16).

McCullough (1973) reported a mean fecal streptococcus concentration of 37,000 organisms/100 ml (n=16) for South Loop 12 and SH 34 near Rosser.

Plankton - McCullough (1973) reported phytoplankton species present at South Loop 12 and SH 34 near Rosser. Table No. XXXI presents these results. The most common organisms encountered are indicative of gross organic pollution, according to Palmer (1969).

McCullough (1973) also measured chlorophyll values at South Loop 12 and SH 34 near Rosser from October 1972 through April 1973. The South Loop 12 station had both the highest mean chlorophyll a and total chlorophyll concentrations. The maximum chlorophyll a concentration reported was 35.4 ug/l, and the minimum was 1.9 ug/l. The maximum and minimum total chlorophyll concentrations were 143.2 ug/l and 3.5 ug/l, respectively.

In addition, McCullough (1973) reported a range in primary production rates of 349 $mgC/m^2/day$ at South Loop 12 in January 1973 to 7430 $mgC/m^2/day$ at SH 34 near Rosser in April 1973.

Periphyton diversity indices (Shannon-Wiener) reported by McCullough (1973) ranged from 0.5 in October 1972 at South Loop 12 to 1.7 in March 1973 at SH 34 near Rosser. Similarly, zooplankton diversity indices reported by the same author ranged from 1.08 in November 1972 to 2.72 in March 1973, both at South Loop 12. SH 34 near Rosser had the highest mean zooplankton diversity index, however. The seven month (September 1972 through March 1973) mean index for Rosser was 2.20.

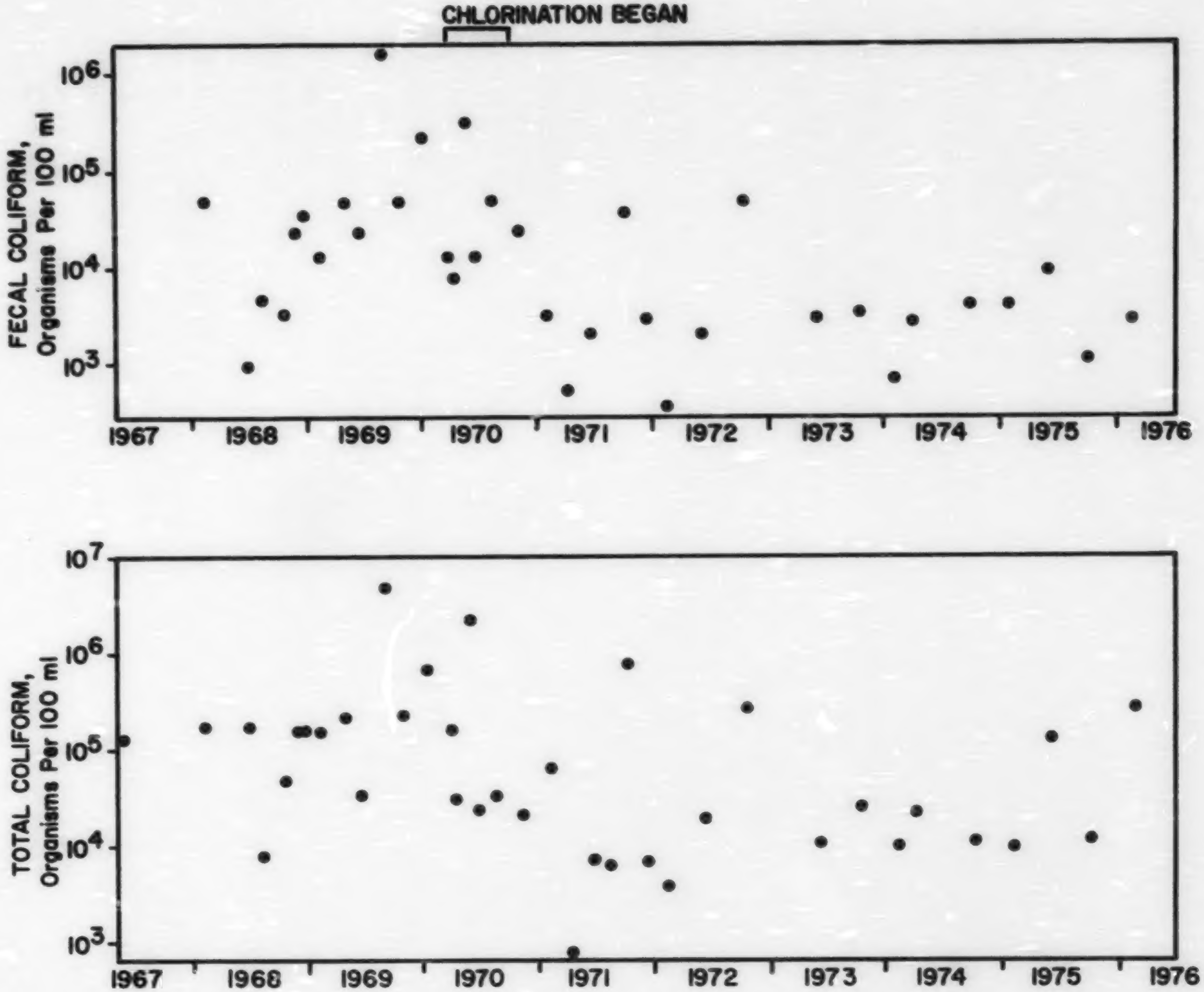


FIGURE G8. HISTORICAL FECAL AND TOTAL COLIFORM DATA FOR SH 34 NEAR ROSSER (SEGMENT 0805).
(DATA FROM TDHR 1967-1976)

TABLE NO. XXXI

PHYTOPLANKTON ENCOUNTERED IN THE TRINITY RIVER FROM THE ELM FORK TO SH 34 NEAR ROSSER
(SEGMENT 0805, PRESENTATION AREA G)

(Taken from McCullough 1973)

	RELATIVE ABUNDANCE*	
Organism	S. Loop 12	Rosser
DIVISION CHLOROPHYTA		
Actinastrum gracilimum		r
A. sp.		r
Ankistrodesmus sp.	o	o
Arthrodesmus incus	r	r
Chlamydomonas sp.		o
Chlorella sp.	o	d
Closteriopsis sp.	f	
Closterium sp.	o	o
Coccomonas sp.		r
Crucigenia rectangularis		r
C. sp.		o
Lagerheimia sp.	o	
Micractinium pusillum	f	f
M. sp.		o
Pandorina sp.		r
Pseudotetrahedron sp.		r
Pteromonas sp.		r
Scenedesmus acuminatus	f	o
S. arcuatus		f
S. bijuga		o
S. denticulatus		r
S. dimorphus	f	f
S. quadricauda	o	a
S. sp.		r
Tetradesmus sp.		r
Tetrastrum sp.		r
DIVISION CHRYSOPHYTA		
Class Bacillariophyceae		
Cymbella ventricosa		r
Cyclotella kutzingiana		r
C. meneghiniana		r
Gomphonema angustatum		o
G. parvulum	d	f
Melosira granulata		r
M. sp.		r
Navicula cryptocephala	f	f

continued. . .

	RELATIVE ABUNDANCE*	
Organism	S. Loop 12	Rosser
N. pusilla	o	
N. rhynchocephala	o	f
N. sp.		o
Nitzschia acicularis	f	a
N. palea	f	f
Pleurosigma sp.		r
Synedra ulna		r
Class Chrysophyceae		
Synura sp.		r
DIVISION CYANOPHYTA		
Chamaesiphon sp.		r
Chroococcus sp.	o	
Oscillatoria sp.	r	r
DIVISION EUGLENOPHYTA		
Euglena acus	o	f
E. hemichromata		r
E. sp.	o	r
Phacus acuminatus		o
P. longicauda	r	f
P. tortus		o

*d - dominant
a - abundant
f - frequent
o - occasional
r - rare

Shannon-Wiener diversity indices less than one indicate severe stress, while indices between one and three are indicative of moderate stress or pollution, according to Wilhm and Dorris (1968).

Aquatic Vegetation - No historical macrophyte surveys were encountered for the Trinity River between the Elm Fork and SH 34 near Rosser.

Macroinvertebrates - Benthic macroinvertebrates reported by McCullough (1973) for South Loop 12 and SH 34 near Rosser are presented in Table No. XXXII. While the Rosser station produced the most organisms, 97% were tubificid worms, and the corresponding diversity index was the lowest for the two stations. Both stations had diversity indices indicative of considerable environmental stress. Ryckman, et al. (1974) also surveyed benthic macroinvertebrates at South Loop 12 and SH 34 near Rosser (Table No. XXXIII). Organisms encountered were similar to those reported by McCullough (1973).

Fishes - Historical fish surveys encountered for the Trinity River and tributaries from the Elm Fork to SH 34 near Rosser are limited to surveys conducted by Fullwood (1950). Fish surveys were conducted on Five Mile Creek, Ten Mile Creek, and Parsons Slough. Results of these surveys are presented in Table No. XXXIV - XXXVI. No parasitic copepoda were recorded.

NONPOINT VS. POINT SOURCE LOADINGS

The Trinity River from the Elm Fork confluence to SH 34 near Rosser (Segment 0805, Presentation Area G) is approximately 84.5 kilometers (52.5 miles) in length. This portion of the Trinity River essentially bisects the Dallas area. Major tributaries to this reach include White Rock Creek, Five Mile Creek, Ten Mile Creek, and the East Fork Trinity River.

Sewage effluent discharged directly into this Presentation Area originates from the Dallas Central-White Rock, Dallas Southside, and TRA Ten Mile Creek STP's. The combined sewage effluent from these plants amounts to approximately 5.85 cubic meters per second (206 cfs), based on TWQB (1975-1976) figures. There are three other domestic and three industrial point sources with average flows in excess of 0.002 cubic meters per second in this segment, according to TWQB (1975-1976). The streamflow in this portion of the Trinity River is extremely variable from the wet period to the dry period of the year. Figure G9 presents a flow frequency curve for the Trinity River below Dallas (South Loop 12). There are definite low and high flow regimes. Under low flow conditions, the segment flow is made up primarily of effluents from existing sewage treatment plants. In general, the low flow in this segment consists of 90 percent sewage effluent. The river is evidently an effluent-dominated stream. In the lower reach of this area, the East Fork adds a considerable amount of low quality water to the river. Problems which

TABLE NO. XXXII

BENTHIC MACROINVERTEBRATES ENCOUNTERED IN THE TRINITY RIVER FROM THE ELM FORK TO SH 34 NEAR ROSSER (SEGMENT 0805, PRESENTATION AREA G)

(Taken from McCullough 1973)

	ABUNDANCE	
Organism	S. Loop 12	SH 34 Near Rosser
Nematoda	1	
Annelida (misc.)	6	109
Tubificidae	247	10,609
Arthropoda		
Insecta		
Diptera		
Chironomidae larvae	32	219
Chironomidae pupae	13	2
Ceratopogonidae		22
Culicidae		
Chaoborus sp.		1
Mollusca		
Gastropoda		
Ferrissia sp.	64	
Misc. Mollusca	4	
Total Organisms Collected	367	10,962
No. Samples	4	5
Mean Diversity Index	1.04	0.34

TABLE NO. XXXIII

BENTHIC MACROINVERTEBRATES
SEGMENT 0805 - PRESENTATION AREA G COLLECTED FEBRUARY, 1974
(TAKEN FROM RYCKMAN, ET AL. 1974)

	ORGANISM ABUNDANCE*	
Macroinvertebrate Species	South Loop 12	SH 34 Near Rosser
Brachycercus sp.		2
Argia violacea		1
Psychodidae	a	
Chironomus plumosus	15	6
Pentaneura sp.		5
Unidentified Tendipedids		15
Unidentified Chironomids	30	
Gammarus sp.		4
Lirceus sp.		2
Lumbriculidae		3

*basket-tub samples
a = abundant

TABLE NO. XXXIV

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR FIVE MILE CREEK (SEGMENT 0805)

(Taken From Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	20	1½"-2"
Notropis lutrensis Plains red shiner	32	1½"-3"
Ceratichthys vigilax (*Pimephales vigilax* (Baird & Girard)) Bullnose minnow (Bullhead minnow)	51	1"-2½"
Campostoma anomalum Stoneroller	60	1½"-3¼"
Gambusia affinis Mosquitofish	8	1½"-2"
Lepomis macrochirus Bluegill	26	1"-7"
Huro salmoides (*Micropterus salmoides* (Lacepede)) Black bass (Largemouth bass)	5	6"-9"
Hydropterus scierus (*Percina sciera* (Swain)) Dusky darter	25	2"-4'
Ictalurus lacustris (*Ictalurus punctatus* (Rafinesque)) Southern channel catfish	11	5½"-7"
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) Black bullhead	12	3"-8"
Schilbeodes nocturnus (*Nocturus nocturnus* (Jordan & Gilbert)) Freckled madtom	8	1"-1½"

continued. . .

Species	Number Captured	Size Range
Ameiurus natalis (*Ictalurus natalis* (Lesueur)) Yellow bullhead	12	2½"-3½"
Carpiodes carpio Carpsucker	16	2½"-14"
TOTAL	286	

No parasitic Copepoda were observed in or on the fish collected.

TABLE NO. XXXV

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR TEN MILE CREEK (SEGMENT 0805)

(Taken From Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	4	1"-1½"
Notropis lutrensis Plains red shiner	41	2"-2½"
Ceratichthys vigilax (*Pimephales vigilax* (Baird & Girard)) Bullnose minnow (Bullhead minnow)	15	2½"-3"
Campostoma anomalum Stoneroller	15	1½"-3"
Lepomis macrochirus Bluegill	20	2¼"-3½"
Dorosoma cepedianum Gizzard shad	38	2"-5½"
Hydropterus scierus (*Percina sciera* (Swain)) Dusky darter	8	2½"-3½"
Ictalurus lacustris (*Ictalurus punctatus* (Rafinesque)) Southern channel catfish	10	3"-5½"
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) Black bullhead	6	2"-5½"
Carpiodes carpio Carpsucker	17	3¼"-9"
TOTAL	174	

No parasitic Copepoda were observed in or on the fish collected.

TABLE NO. XXXVI

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR PARSONS SLOUGH (SEGMENT 0805)

(Taken From Fullwood 1950)

Species	Number Captured	Size Range
Notropis lutrensis Plains red shiner	15	1½"-2"
Lepomis macrochirus Bluegill	8	2"-2½"
Ameiurus melas catalus (Ictalurus melas (Rafinesque)) Black bullhead	5	1½"-2"
TOTAL	28	

No parasitic Copepoda were observed in or on the fish collected.

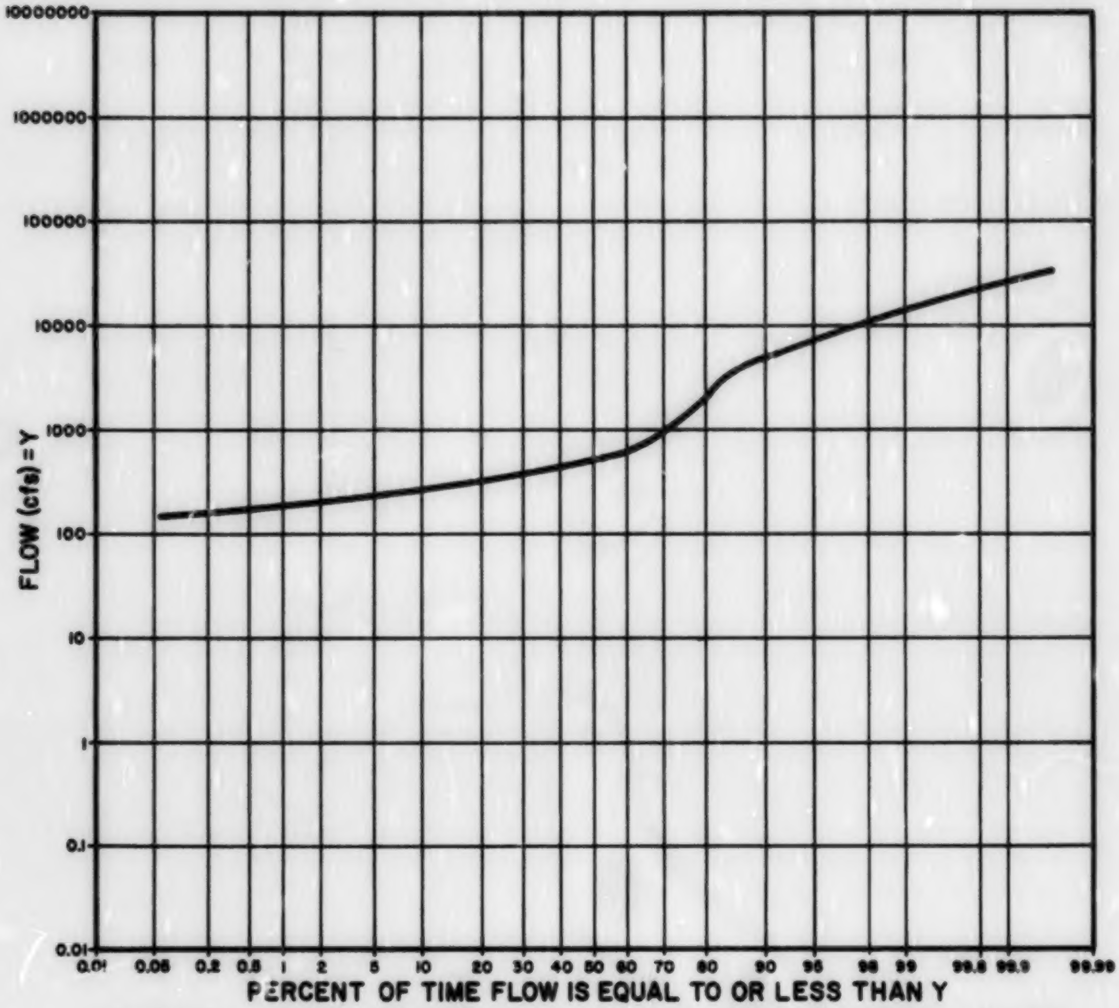


FIGURE G9 . FLOW FREQUENCY ANALYSIS FOR THE TRINITY RIVER BELOW DALLAS (USGS 08057410).

(DATA FROM USGS 1957-1970)

are characteristic of sewage effluent such as high levels of ammonia, phosphate, BOD, suspended solids, and coliform bacteria, as well as low levels of dissolved oxygen, are commonly observed in the river. Associated with the suspended solids from various sewage treatment plants, sludges accumulate on the side banks along the river. This accumulation is particularly evident throughout the sections immediately downstream from sewage outfalls and sections with relatively wide cross-sectional areas.

Figure G10 presents the concentration and flux of total phosphorus during high flow events at SH 34 near Rosser (USGS 08062500). This figure reveals that runoff related pollution during high flow contributes a significant amount of phosphorus to the river. These high levels of phosphorus pose no immediate problem to the aquatic environment; however, they will tend to enhance eutrophic symptoms in mainstream Trinity River reservoirs (e.g., Lake Livingston). The Trinity River Authority has sampled several Trinity River stations during various rainfall/runoff events under contract with the TWQB. Due to the complexity of the problem and its study, however, further investigation should be undertaken.

Figure G11 shows a profile of the ratio of total suspended solids at high flow to base flow conditions for the period August 31, 1976 to September 8, 1976 at SH 34 near Rosser. During the event, streamflow at Rosser varied from 14 cubic meters per second (500 cfs) to about 170 cubic meters per second (6000 cfs). This streamflow constituted only a moderately high flow, but the solids flux changed significantly, varying from 16,800 kg/day (37,000 lbs/day) to 15,700,000 kg/day (34,600,000 lbs/day).

An urban runoff study conducted by the City of Dallas in November, 1975 produced several interesting results. Among these were the following:

1. The dissolved oxygen concentration ranged from 2 mg/l to 12 mg/l (i.e., the TWQB (1976a) criterion for Segment 0805 of 2.0 mg/l (minimum) was met),
2. Coliform bacteria concentrations were roughly equivalent to those measured during low flow conditions,
3. Concentrations of lead and manganese were high, possibly due to the burning of leaded gasolines and subsequent deposition on urban streets,
4. Main Stem Trinity River samples had the highest concentrations of nitrogen and phosphorus.

WATER USES

Domestic and Municipal

The West Fork Trinity River from the confluence of the Elm Fork to SH 34 near Rosser is not used as a source of municipal and domestic

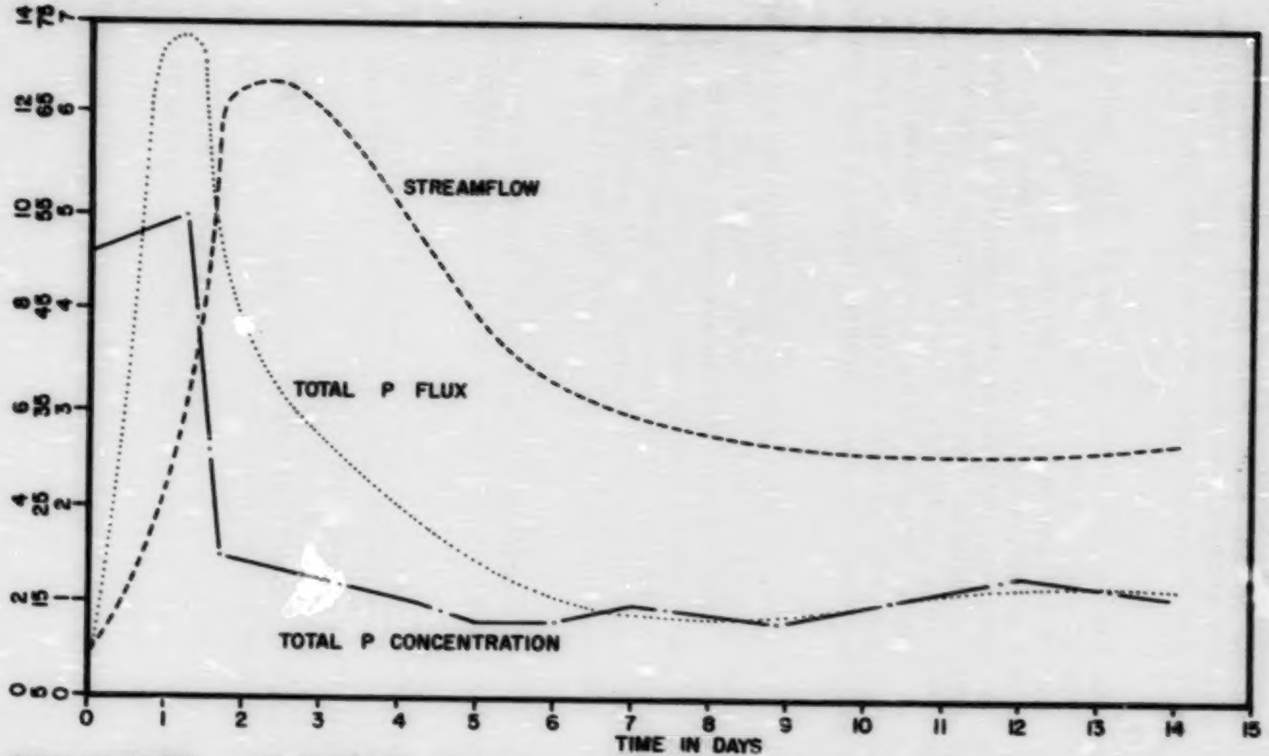
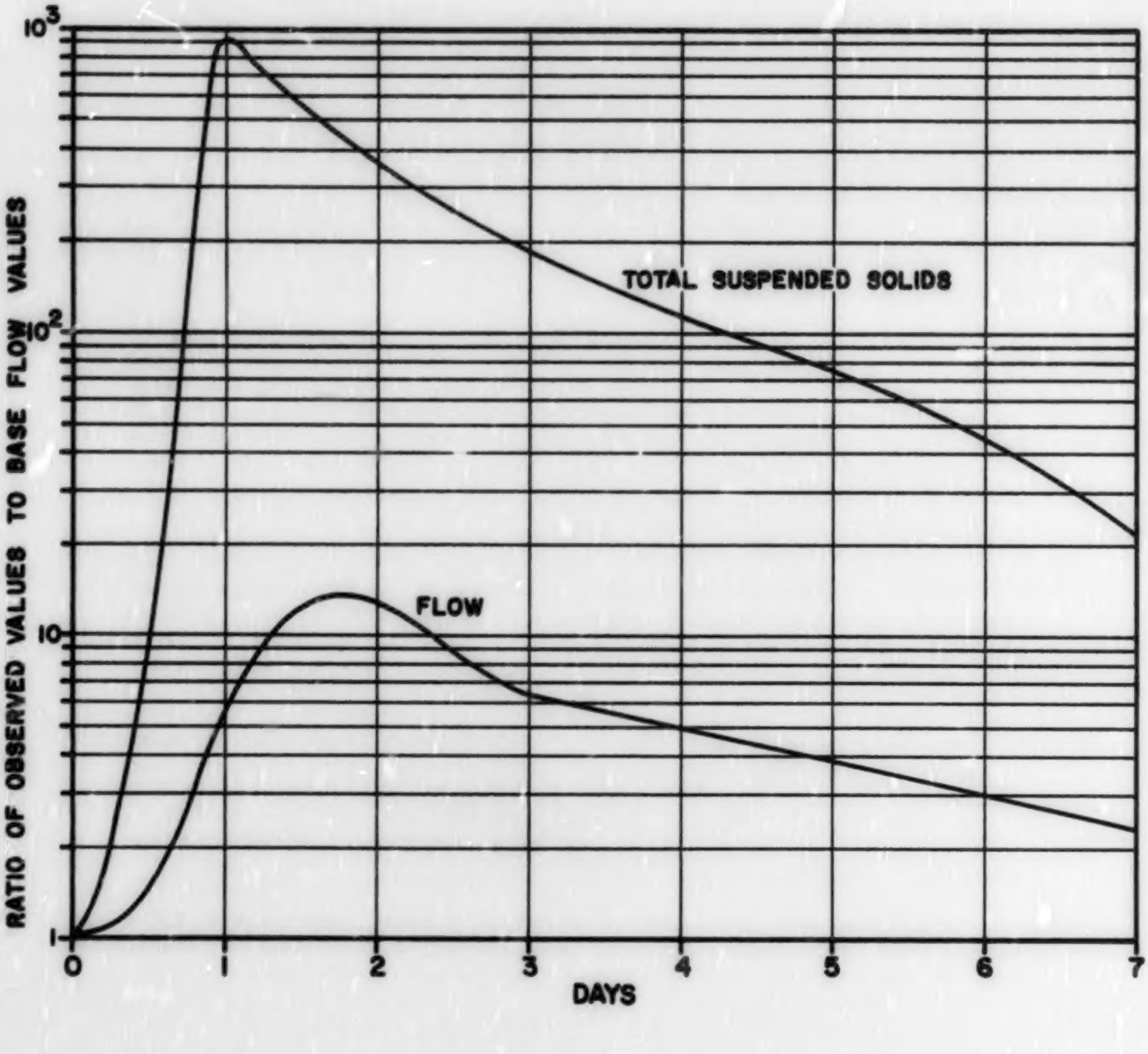


FIGURE 6.10. CONCENTRATION AND FLUX OF TOTAL PHOSPHORUS vs. STREAMFLOW AT SH 34 NEAR ROSSER (Sept. 26 - Oct. 10, 1973)
(DATA FROM TRA 1973)

FIGURE G11 .
EFFECT OF HIGH FLOWS UPON SUSPENDED SOLIDS AT SH 34 NEAR ROSSER (Segment 0805).
(DATA FROM TRA USGS)



waters. Except for a certified filing held by the City of Dallas, there are no permits for the removal of water from this segment for domestic and municipal uses.

Agricultural and Industrial

The West Fork Trinity River between the confluence with the Elm Fork and SH 34 near Rosser is not used, according to present record, as a source of either agricultural or industrial waters.

Recreational

The recreational uses of the West Fork (Presentation Area G) are much the same as those for Presentation Area F. There is very little change in the quality of the water between these two areas, and because it is of such poor quality, water contact activities are undesirable.

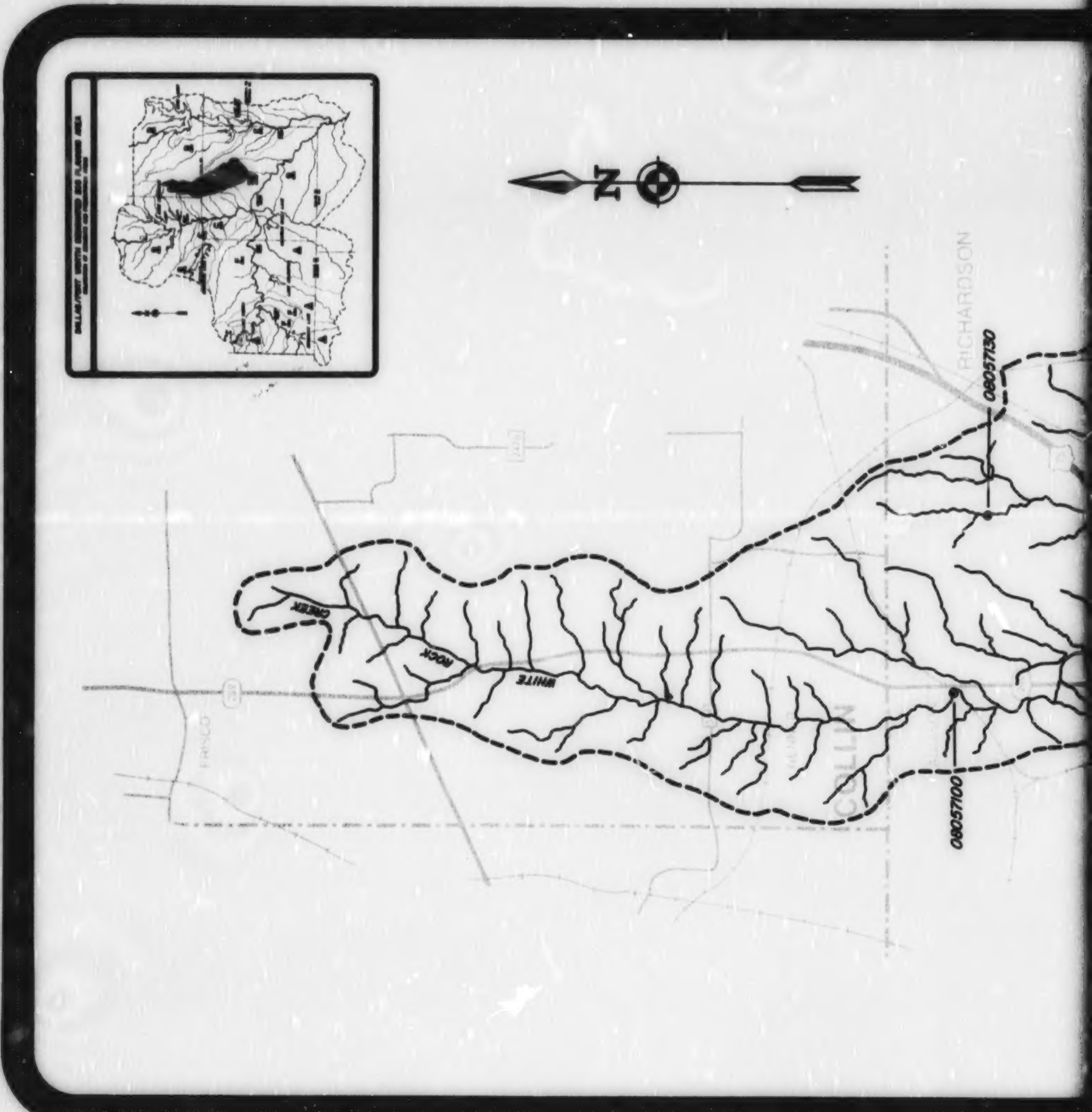
SUMMARY

Water quality in the Trinity River from the Elm Fork confluence to SH 34 near Rosser is poor. TWQB (1976a) criteria which were violated were the ones for fecal coliform and dissolved oxygen. The log. mean fecal coliform concentration was greatly in excess of the Segment 0805 TWQB (1976a) standard of 2000 organisms/100 ml. Also, the reported dissolved oxygen concentration was often less than the TWQB (1976a) standard of 2.0 mg/l. Other problems in this portion of the Trinity River include high nutrient and BOD concentrations, high chlorophyll a concentrations, and periodic high suspended sediment concentrations.

Water entering the Trinity River from major tributaries is of relatively good quality. Sediment analyses for the Trinity River between the Elm Fork and SH 34 near Rosser indicate the presence of large concentrations of several parameters, particularly nitrogen and phosphorus.

Bacteria data on this segment of the Trinity River indicate some improvement in conditions over the years, although some periodic high concentrations are noted. Other biological data, both recent and historical, reveal very low diversity indices for the Trinity River. This is indicative of a high degree of stress being exerted upon the biological community.

Historical water analyses for the Trinity River indicate that there has been an improvement in conditions over the past 50 years. Trends over the more recent historical period are less defineable.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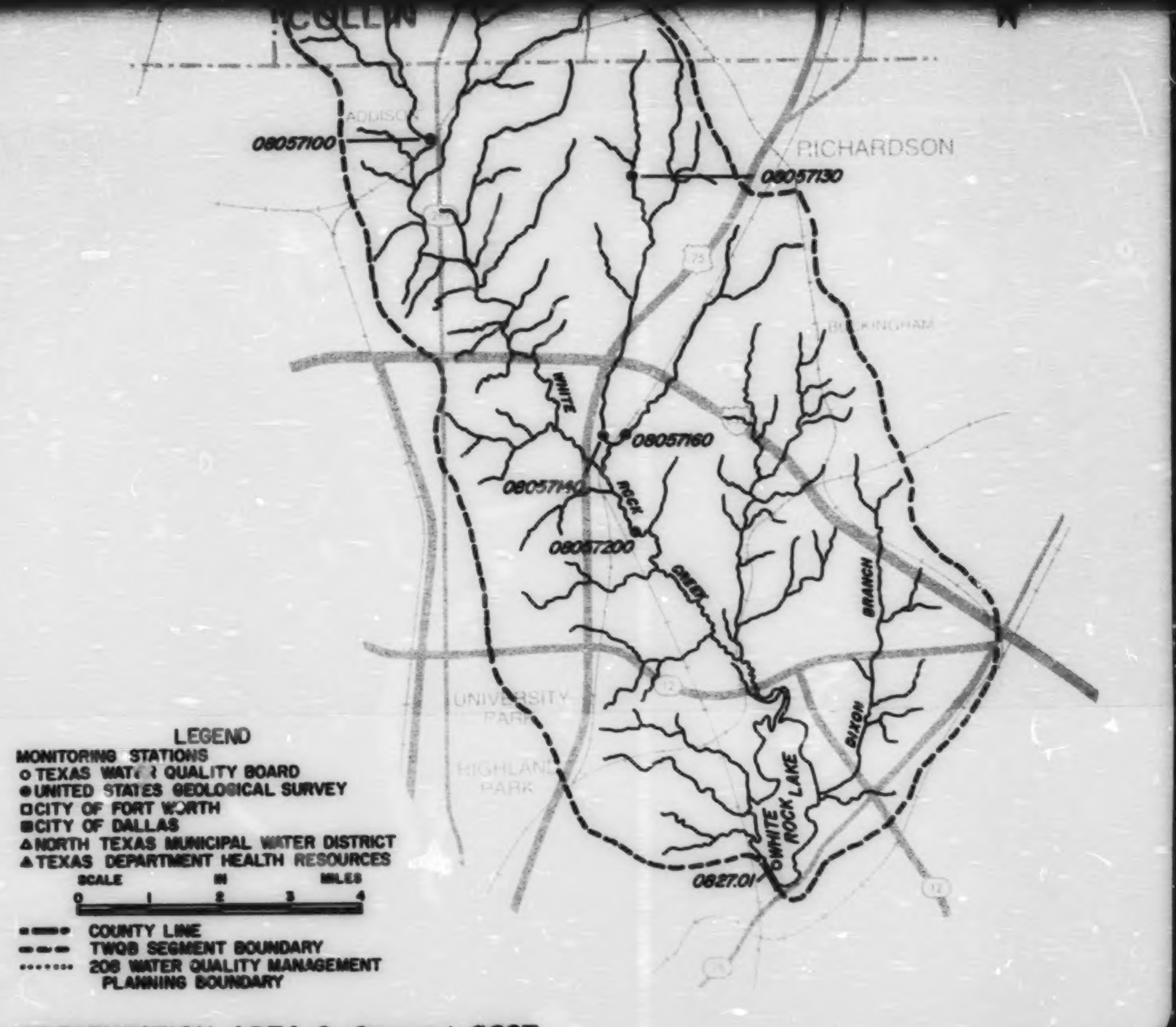
08057130
08057100
COLLIN
FRISCO
WHITE
ROCK
CREEK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ADDISON
RICHARDSON
BUCKINGHAM
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08057140
08057200
0827.01
WHITE
ROCK
CREEK
BRANCH
DIXON
WHITE ROCK LAKE
UNIVERSITY PARK
HIGHLAND PARK
75
12
LEGEND
MONITORING STATIONS
○ TEXAS WATER QUALITY BOARD
● UNITED STATES GEOLOGICAL SURVEY
□ CITY OF FORT WORTH
■ CITY OF DALLAS
△ NORTH TEXAS MUNICIPAL WATER DISTRICT
▲ TEXAS DEPARTMENT HEALTH RESOURCES
SCALE IN MILES
0 1 2 3 4
COUNTY LINE
TWQB SEGMENT BOUNDARY
208 WATER QUALITY MANAGEMENT PLANNING BOUNDARY

PRESENTATION AREA G-Segment 0827

TRINITY RIVER AUTHORITY OF TEXAS December 1976
Planning and Environmental Management Division FIGURE G12

WHITE ROCK LAKE - Segment 0827

White Rock Lake was constructed during the period 1910-1911, primarily for municipal water use. Normal capacity was first achieved in August 1911. The surface area of White Rock Lake is about 4.53 square kilometers (1119 acres), and the volume is about 1.32 x 10^7 cubic meters (10,740 acre-feet). The drainage area of White Rock Lake is 259 square kilometers (100 square miles), and the mean depth is 2.9 meters (9.6 feet).

RECENT WATER QUALITY DATA

Chemical-Physical
(10-1-74 through 6-30-76)

Water Analyses - White Rock Lake (TWQB 0827.01). All concentrations are in mg/l, unless otherwise specified. All samples are surface grab samples.

Parameter	Mean	Max	Min	S	N
Temperature (C)	19.1	28.0	5.5	8.6	7
Dissolved Oxygen	9.0	12.1	4.5	2.6	7
Conductivity (umhos/cm)	351	420	284	67	7
pH (pH units)	7.8	8.5	7.2	0.4	7
Total Suspended Solids	24	37	10	10	6
Volatile Suspended Solids	12	18	9	3	6
Total Dissolved Solids	181	217	150	33	6
Ammonia, as N	0.10	0.16	0.03	0.05	7
Nitrate, as N	0.4	1.2	0.0	**	7
Total Phosphate, as P	0.14	0.30	0.03	**	6
Orthophosphate, as P	0.08	0.15	0.03	0.04	7
Chloride, as Cl	25	44	11	11	7
Sulfate, as SO_4	35	47	23	8	7
Fecal Coliform (#/100 ml)	52*	4000	8	**	6
Chlorophyll a (ug/l)	26	44	15	10	7
Secchi (cm)	53	76	30	-	4

-Standard deviation not computed when N is less than six.
*Log. mean to conform to standards.
**Data from a clearly non-normal distribution; no standard deviation computed.

Water Quality Standards - These standards for water quality in White Rock Lake were taken from TWQB (1976a).

Temperature - Not to exceed 33.9 °C. Criterion met.
Dissolved Oxygen - Concentration not to be less than 5.0 mg/l. Criterion not met (out of seven reported values, one was below 5.0 mg/l).
pH - Acceptable range: 7.0 - 9.0. Criterion met.

Total Dissolved Solids - Mean concentration not to exceed 400 mg/l. Criterion met (no reported values exceeded 400 mg/l).
Chloride - Mean concentration not to exceed 100 mg/l. Criterion met (no values reported in excess of 100 mg/l).
Sulfate - Mean concentration not to exceed 100 mg/l. Criterion met (no values reported in excess of 100 mg/l).
Fecal Coliform - Log. mean not to exceed 200 organisms/100 ml. Criterion met.

White Rock Lake has adequate nutrients to support a considerable phytoplankton community. This is evidenced by the relatively high chlorophyll a concentrations. Outside of a few low dissolved oxygen values, water quality in White Rock Lake appears to be good. Figures G13 and G14 present recent vertical profiles in White Rock Lake for the parameters dissolved oxygen, temperature, and pH for summer and winter conditions. During the summer, very little surface-to-bottom difference occurs with temperature, while dissolved oxygen drops to near zero at approximately four meters.

Tributary Water Analyses - Tributaries of White Rock Lake include White Rock Creek and Dixon Branch. The USGS operates two gaging stations on White Rock Creek (USGS 08057100, 08057200), both upstream from White Rock Lake. The two stations have a combined drainage area of 248 square kilometers (95.8 square miles) and reported a combined average flow of 3.04 cubic meters per second (107.3 cfs) during WY 1975. No data from Dixon Branch were encountered.

Sediment Analyses - No recent data concerning analyses of pollutants in sediment were encountered.

Biological
(10-1-74 through 6-30-76)

Bacteria - Data concerning fecal coliform bacteria were presented in the WATER ANALYSES section of this segment. The fecal coliform logarithmic mean was 52 organisms/100 ml. The reported range of the data was from 8 to 4000 organisms/100 ml.

No other recent biological data for this segment were encountered.

HISTORICAL WATER QUALITY TRENDS

Chemical-Physical
(Prior to 10-1-74)

Water Analyses - The TWQB began reporting on the quality of water in White Rock Lake in September 1973. Since that time, there appears to have been very few problems with the water quality. Concentrations of chloride, sulfate, conductivity, ammonia, orthophosphate, and suspended sediment all appear to be fairly low. Dissolved oxygen remained rela-

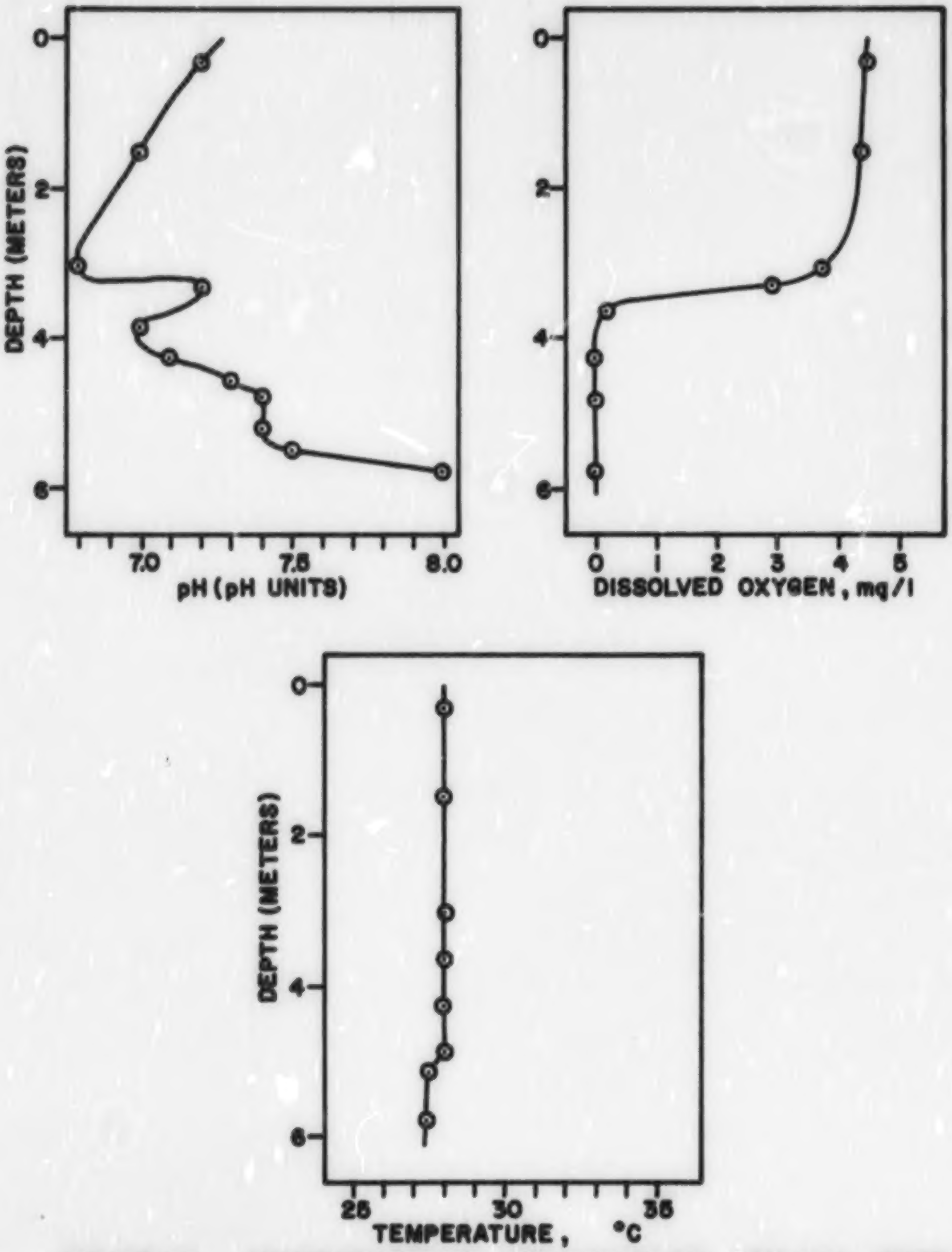


FIGURE G13. REPRESENTATIVE STRATIFICATION VERTICAL PROFILES IN WHITE ROCK LAKE FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON AUGUST 14, 1975 (TIME 1000).
(DATA FROM TWQB 0827.01)

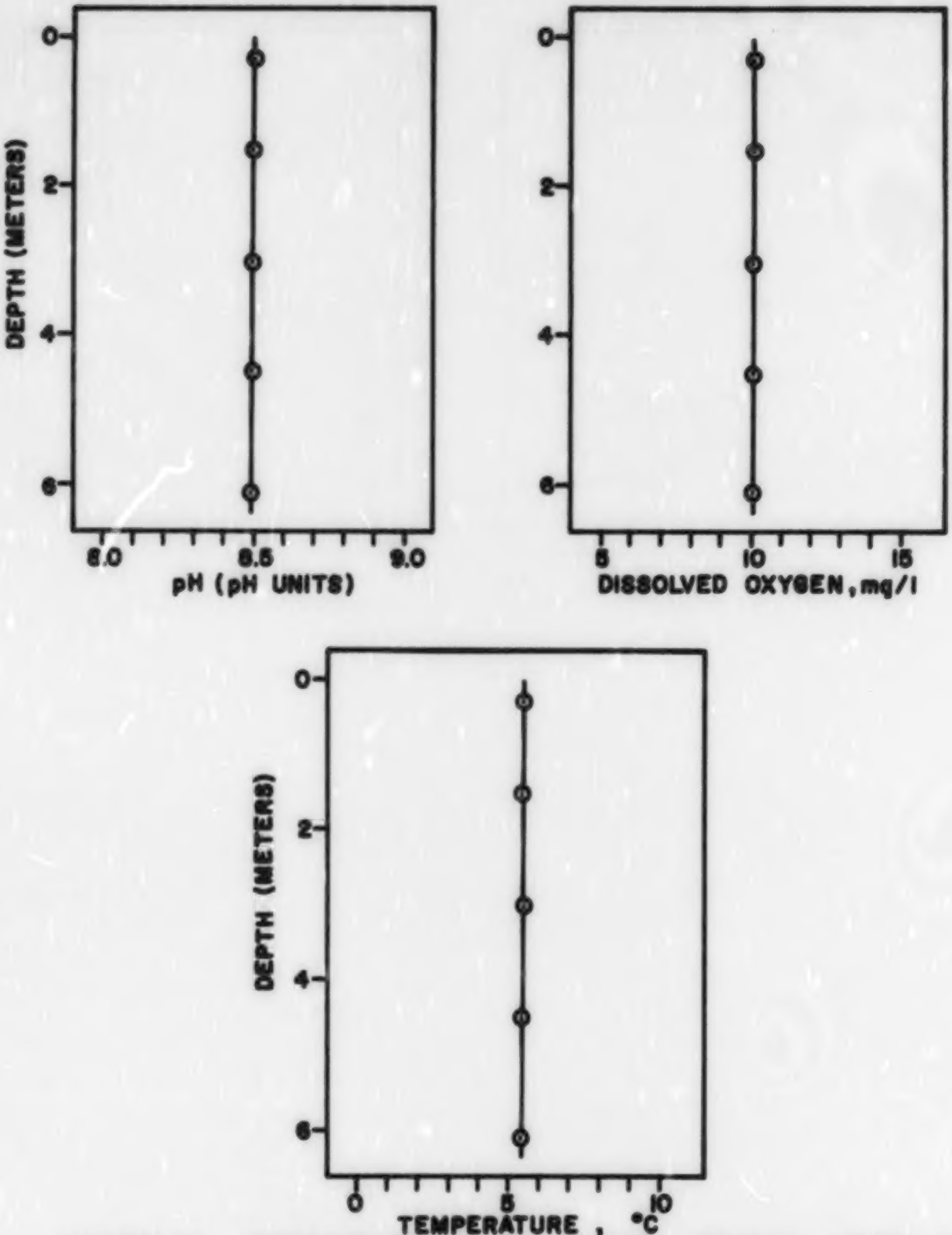


FIGURE G14. REPRESENTATIVE HOLOMICTIC VERTICAL PROFILES IN WHITE ROCK LAKE FOR pH, DISSOLVED OXYGEN, AND TEMPERATURE ON DECEMBER 2, 1974 (TIME 1240).
(DATA FROM TWQB 0827.01)

tively high with an average of 8.2 mg/l. Nitrate, total phosphate, and fecal coliform bacteria were moderately high with reported maxima of 1.02 mg/l, 0.46 mg/l, and 530 organisms/100 ml respectively.

Due to the fact that so few historical data are available, no conclusions may be drawn concerning historical trends.

Tributary Water Analyses - Few historical water quality data were encountered for tributaries entering White Rock Lake.

Sediment Analyses - No historical analyses for sediment pollutants were encountered. Sedimentation rate, however, was studied by the Soil Conservation Service (SCS) in 1971. It was reported that reservoir capacity loss during the period 1935-1970 due to sedimentation ranged from 95% in White Rock Lake headwaters to 24% in a segment of the lake 2000-3000 feet upstream from the dam. During this same period, the amount of urban land area in the White Rock Lake watershed increased from 6% (1935) to 55% (1970). Conversely, the amount of cropland decreased from 70% to 29% (SCS 1971).

Biological
(Prior to 10-1-74)

Bacteria - No historical bacteria data were encountered for White Rock Lake or upper White Rock Creek.

Plankton - Patterson (1941) studied the plankton community of White Rock Lake. During a six month period, one station was collected at regular intervals. It was found that:

1. Diatoms were the most abundant group throughout the study. Other groups encountered in the study were (in decreasing order of abundance) copepods, non-desmid algae, cladocera, protozoa, and desmids.
2. Although protozoa were never very abundant, the more common genera included *Ceratium*, *Difflugia*, and *Dinobryon*.
3. Rotifers were the most abundant zooplankters. The more common genera encountered were *Keratella*, *Polyarthra*, and *Filinia*. Other zooplankters encountered include the genera *Diaptomus*, *Cyclops*, *Daphnia*, *Bosmina*, and *Diaphanosoma*.

Macroinvertebrates - Several surveys of macroinvertebrates have been conducted in Segment 0827. Glass (1950) observed the aquatic Coleoptera in White Rock Creek and White Rock Lake. Organisms encountered include *Dineutus americanus* Say, *Haliplus punctatus* Aube, *Peltodytes litoralis* Math., *Berosus peregrinus* (Hbst.), *Enochrus nebulo-*

sus (Say), *Tropisternus lateralis* (Fabr.), *Laccophilus fasciatus* Aube, *Hydroporus dimidiatus* G&H, *H. diversicornis* Shp., *Bidessus pulicarius* (Aube), and *B. affinis* (Say). According to Glass (1950), the White Rock Creek and White Rock Lake area seemed to have the greatest diversity of aquatic Coleoptera in the Dallas area.

Hall (1950) also surveyed macroinvertebrates (Tricoptera) in Dallas County. During his study, *Oecetis cinerascens* was encountered in White Rock Creek. This finding seemed to indicate that, in this particular respect, White Rock Creek was somewhat similar to the northern half of the county.

Moore (1950) made a population study comparing the diversity of mayflies in White Rock Creek with that found in White Rock Lake. The following table illustrates the differences found between populations of the two habitats.

White Rock Creek	White Rock Lake
Family Heptageniidae	
Stenonema candidum	
S. terminatum	
S. tripunctatum	
Family Baetidae	
Choroterpes sp.	
Caenis sp.	*Caenis* sp.
Tricorythodes sp.	
Isonychia sp.	
Baetis parvus-brunneicolor	

Aquatic Vegetation - No historical information regarding aquatic macrophytes present in White Rock Lake was encountered.

Fishes - Fullwood (1950) lists fish species and parasitic copepoda encountered in White Rock Lake and White Rock Creek in Table No. XXXVII. Several parasites were encountered, predominantly on catfish.

NONPOINT VS. POINT SOURCE LOADINGS

Insufficient data exist for the determination of relative source loadings of point versus nonpoint sources entering White Rock Lake. However, according to TWQB (1975-1976), there is only one domestic point source with a flow in excess of 0.002 cubic meters per second in the White Rock Lake watershed.

WATER USES

Domestic and Municipal

White Rock Lake is not currently being used as a source of domestic and municipal water. According to NCTCOG (1974), during an unforeseen

TABLE NO. XXXVII

FISH CAPTURED AND PARASITIC COPEPODA NOTED FOR WHITE ROCK LAKE AND CREEK (SEGMENT 0827)

(Taken from Fullwood 1950)

Species	Number Captured	Size Range
Fundulus notatus Blackband topminnow	71	1½"-3"
Notropis lutrensis Plains red shiner	89	2"-3"
Notropis venustus Texas spot-tail shiner (Blacktail shiner)	53	2"-3¼"
Pimephales promelas Southern fathead minnow	13	2"-3½"
Ceratichthys vigilax (*Pimephales vigilax* (Baird & Girard) Bullnose minnow (Bullhead minnow)	77	3/4"-3½"
Campostoma anomalum Stoneroller	69	2"-4"
Notemigonus crysoleucas Golden shiner	8	3"-4"
Gambusia affinis Mosquitofish	42	2"-2½"
Labidesthes sicculus Brook silverside	51	2"-3¼"
Lepomis macrochirus Bluegill	25	2"-3"
Lepomis megalotis Longear sunfish	27	2"-7½"
Lepomis humilis Orangespotted sunfish	21	2½"-4"
Lepomis microlophus Redear sunfish	10	2"-3"

continued. . .

Species	Number Captured	Size Range
Lepomis cyanellus Green sunfish	11	2"-3"
Pomoxis annularis White crappie	38	2½"-10"
Huro salmoides (*Micropterus salmoides* (Lacepede)) Black bass (Largemouth bass)	15	4"-19"
Lepibema chrysops (*Roccus chrysops* (Rafinesque)) Sandbass (White bass)	15	4"-19"
Dorosoma cepedianum Gizzard shad	35	7½"-14"
Hydropterus scierus (*Percina scierus* (Swain)) Dusky darter	27	2½"-4¼"
Boleosoma chlorosomum (*Etheostoma chlorosomum* (Hay)) Bluntnose darter	14	2"-2¼"
Megastomatobus cyprinella (*Ictiobus cyprinellus* (Valenciennes)) Big mouth buffalo (Largemouth buffalofish)	15	3"-4½"
Cyprinus carpio Carp	11	7"-11"
Ictalurus lacustris (*Ictalurus punctatus* (Rafinesque)) Southern channel catfish	43	3"-22"
Ameiurus melas catalus (*Ictalurus melas* (Rafinesque)) Black bullhead	50	3½"-9"
Ameiurus natalis (*Ictalurus natalis* (Lesueur)) Yellow bullhead	39	3"-8½"

continued. . .

Species	Number Captured	Size Range
Schilbeodes nocturnus (Nocturus nocturnus (Jordan & Gilbert)) Freckled madtom	20	1½"-3¼"
Total	889	

Note: Parasitic Copepoda observed on fish collected in this area were Ergasilus versicolor (found on 47 fish), Argulus mississippiensis (on six fish), and Lernaea cyprinacea and Achtheres pimelodi (both occurring on one fish).

emergency the City of Dallas has the authority to divert water from White Rock Lake. Although no water is currently being used, the calculated dependable yield of the lake is 0.55 cubic meters per second (12.6 MGD).

Industrial and Agricultural

White Rock Lake is not used as a source of either industrial or agricultural water.

Recreational

White Rock Lake is heavily used for recreation. Activities occurring on and around the lake include boating, fishing, picnicking, and hiking.

SUMMARY

Water quality in White Rock Lake is fair, exhibiting a few problems. The TWQB (1976a) criterion for dissolved oxygen was violated. In addition, nutrients appear to be relatively plentiful and appear to support a substantial phytoplankton community, as evidenced by the high chlorophyll *a* values. The lake undergoes extensive summer stratification, particularly with regard to dissolved oxygen. Relatively few data, both recent and historical, were encountered for White Rock Lake, and an analysis of trends in the lake is impossible.

Biological data are primarily composed of bacteria data. Some historical surveys of plankton, macroinvertebrates, and fishes have been conducted on White Rock Lake with no particular problems indicated.

Additional Data Needs

The Trinity River from the mouth of the Elm Fork to the SH 34 bridge has essentially the same additional data needs as the West Fork from Beach Street to the Elm Fork. Additional data are needed to 1) determine diurnal variations in various parameters including dissolved oxygen, pH, bacteria, and ammonia, which may be caused by diurnal variations in wastewater treatment plant discharges and/or photosynthesis, particularly during base flow conditions, 2) determine the chemical and physical characteristics of the black sediments which develop on the river bottom during low flow conditions and are resuspended during high flows, 3) determine the quality of rainfall runoff from subwatersheds which are tributary to the segment, 4) determine the quality and rate of discharge from wastewater treatment plants during periods of rainfall/runoff and infiltration to collection systems, and 5) determine the response of the river to all inflows and conditions during rainfall runoff. As for the parameters which should be analyzed, the known and documented problems in the segment are directly related to dissolved oxygen and biochemical oxygen demand, fecal coliform bacteria, ammonia and other forms of nitrogen, phosphorus, suspended solids, algae, flow, and rainfall. Four types of data-collection programs are required:

a) Continuous automated monitoring of dissolved oxygen, temperature, pH, and conductivity, along with flow, on the Trinity River at Westmoreland Street, South Loop 12, and SH 34 will directly satisfy some of the needs of (1) and (5), and indirectly some of the other needs, listed above. This monitoring is now being installed by the USGS under contract with the North Central Texas Council of Governments as a part of the overall 208 planning project, and is to be continued with combined support of the USGS, the Texas Water Development Board, and local water agencies.

b) Sampling and analysis of the West Fork and selected tributary watersheds during rainfall runoff events, to be done during 1977 under a subsequent part of the contract under which this report is prepared, will address (3), (4), and (5), above.

c) Frequent sampling and analysis of major point source discharges during rainfall runoff events, to be done at the same time as (b), above, will help to satisfy the same data needs.

d) Sampling and analysis of river bottom sludges and sediments during periods of low flow, to be done under a subsequent part of the contract under which this report is prepared, will address (2), above.

White Rock Lake has limited data available to determine historical trends or to distinguish between point and nonpoint source loadings. Further data collection and analysis on White Rock Lake can best be determined after the completion of, and based upon the results of, the study of Lake Ray Hubbard now underway under another part of the 208 planning project.

GROUNDWATER

WATER-BEARING FORMATIONS

The character and distribution of groundwater reservoirs in the Dallas-Fort Worth metroplex area are related to the geologic history of Texas. Rocks of nearly all ages, varying from early Paleozoic to current are found in the area. These rocks include Pennsylvanian and older rocks, Trinity group, Fredericksburg and Washita groups, Woodbine group, Eagle Ford, and Austin and Taylor groups. Practically all of the formations yield some water, but relatively few yield sufficient quantities of usable water to be considered major aquifers. Almost all of the groundwater used in the metroplex area is withdrawn from one of two major aquifers. These two major aquifers are the Trinity group and the Woodbine formation. Figures GW1 and GW2 present the typical distribution of the geologic formations through the area, showing the orientation of these two aquifers and their relationship to other formations.

TRINITY GROUP

The Trinity aquifer provides groundwater supplies for most of the rural areas and for many industries in the metroplex. This aquifer covers most of the upper Trinity Basin outcrops in Montague, Wise, Hood, Parker, and western Cooke Counties and dips to the East and Southeast. The location and extent of the Trinity group is shown on Figures GW1 and GW2. As shown in the figures, the thickness of the formation varies from zero meters at the updip edge of the Trinity group outcrop to nearly 457 meters (1500 feet) in Ellis County. Depths to the top of the Trinity group, undifferentiated, range from zero at the edge of the outcrop to more than 609 meters (2000 feet) in east and southeast of Dallas County. In the outcrop area, the Trinity group contains fine-grained quartz sand in layers as thick as 15 meters (50 feet) (TWC 1963). Some coarse sand and gravel appear in the base of the formation. The group is subdivided into Travis Peak, Glen Rose, and Paluxy formations. Each of these three formations has distinct geologic characteristics and water-bearing capabilities.

The Paluxy formation is mostly sand varying in thickness from 0 to 137 meters (450 feet) and is the shallowest of the Trinity group. Wells drilled to the Paluxy sand will generally produce only moderate amounts of water. The Glen Rose formation which ranges from 0 to 300 meters (1000 feet) in thickness, lies below the Paluxy. Because it is characteristically composed of low permeability marly limestone, wells drilled to this formation are relatively unproductive. The most prolific water-bearing stratum in the Trinity group is the Travis Peak formation. The depth of this Travis Peak formation changes from 61 to 270 meters (200 to 900 feet). The productive wells which provide municipal supplies, industrial uses, and irrigation may be found in this stratum. In north central Texas, the Travis Peak formation is frequently known as the Twin Mountains formation.

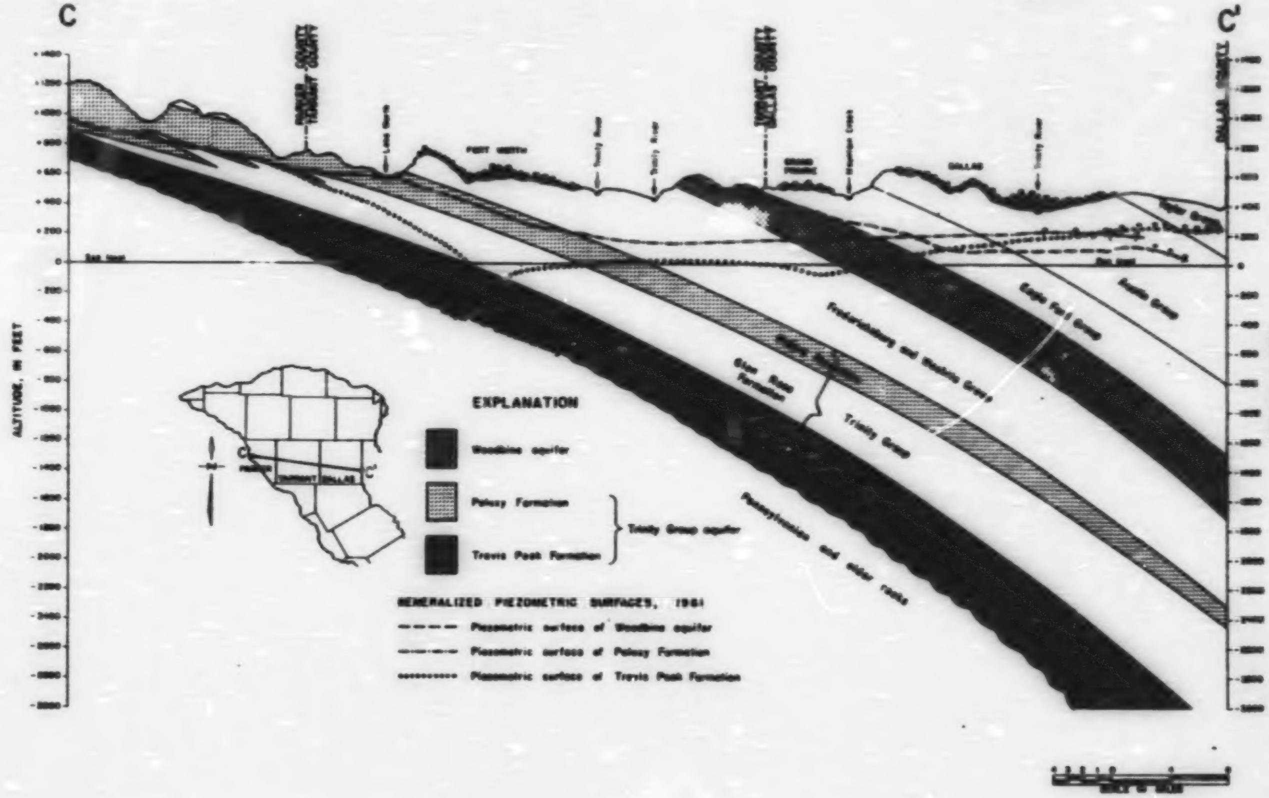

C
C'
ALTITUDE, IN FEET
PARKER COUNTY
TARRANT COUNTY
TARRANT COUNTY
DALLAS COUNTY
DALLAS COUNTY
FORT WORTH
DALLAS
Trinity River
Sea level
Fredericksburg and Washita Groups
Eagle Ford Group
Austin Group
Glen Rose Formation
Trinity Group
Pennsylvanian and older rocks
EXPLANATION
Woodbine aquifer
Paluxy Formation
Travis Peak Formation
Trinity Group aquifer
GENERALIZED PIEZOMETRIC SURFACES, 1961
Piezometric surface of Woodbine aquifer
Piezometric surface of Paluxy Formation
Piezometric surface of Travis Peak Formation
PARKER
TARRANT
DALLAS

FIGURE GW1 A GENERALIZED GEOLOGIC SECTION C-C' OF THE UPPER TRINITY RIVER BASIN
(Data from TWC 1963)

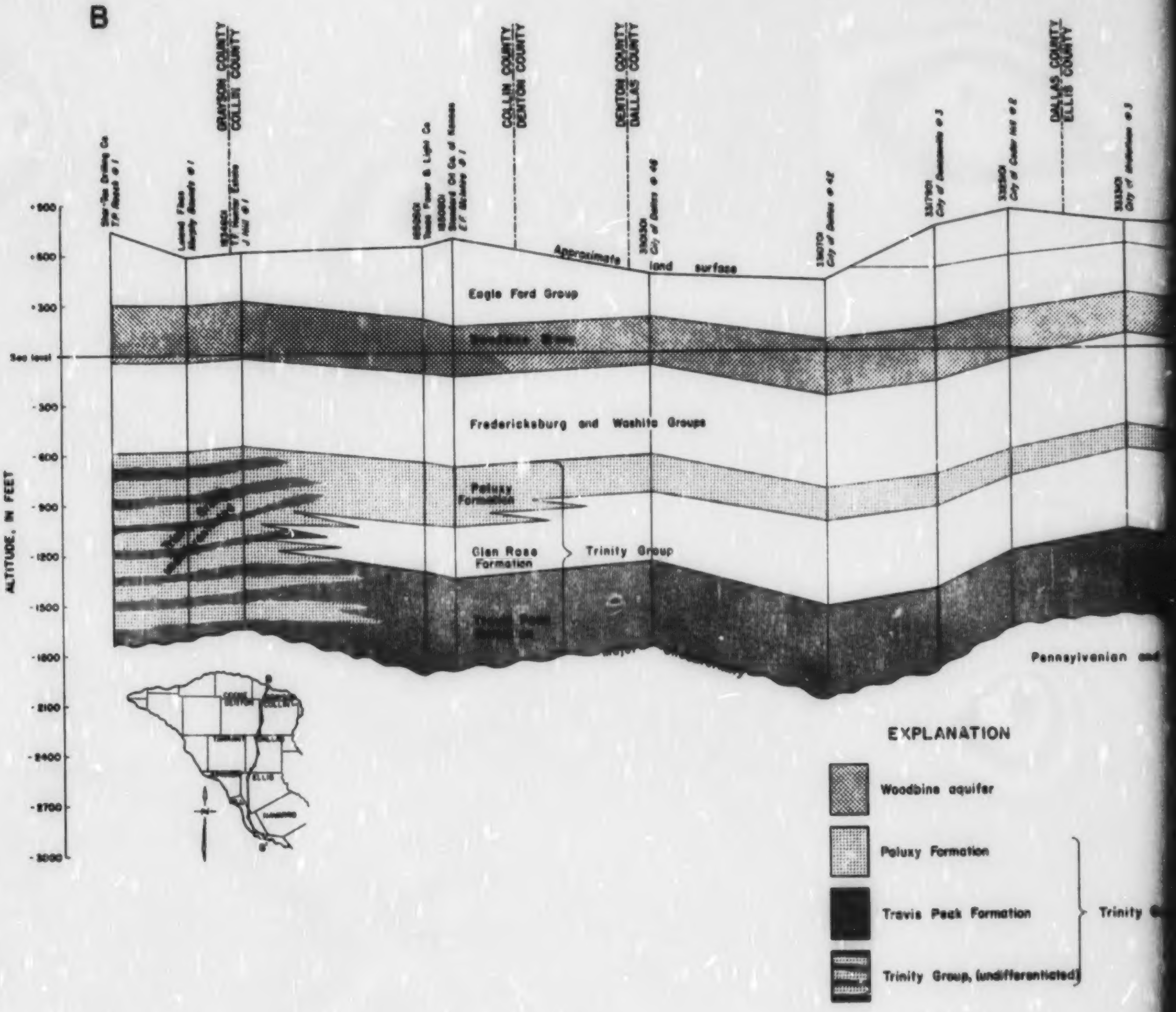
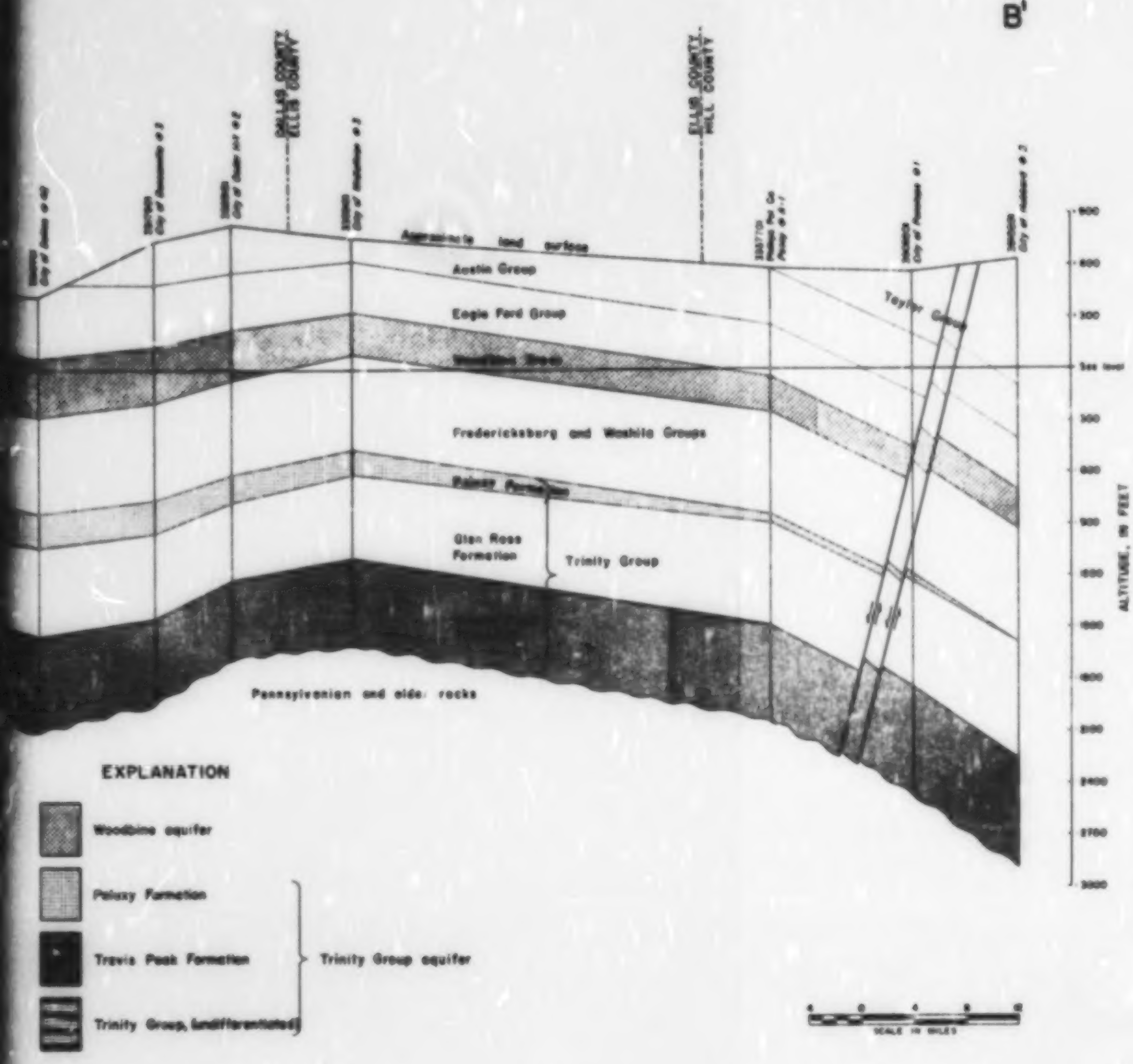

B
GRAYSON COUNTY
COLLIN COUNTY
COLLIN COUNTY
DENTON COUNTY
DENTON COUNTY
DALLAS COUNTY
DALLAS COUNTY
ELLIS COUNTY
Texas Power & Light Co
Standard Oil Co of Kansas
City of Dallas # 46
City of Dallas # 42
City of Duncanville # 3
City of Cedar Hill # 2
+900
+600
+300
Sea level
-300
-600
-900
-1200
-1500
-1800
-2100
-2400
-2700
-3000
ALTITUDE, IN FEET
Approximate land surface
Eagle Ford Group
Woodbine Group
Fredericksburg and Washita Groups
Paluxy Formation
Glen Rose Formation
Trinity Group
Travis Peak Formation
Pennsylvanian and
COOKE
GRAYSON
DENTON
COLLIN
DALLAS
ELLIS
EXPLANATION
Woodbine aquifer
Paluxy Formation
Travis Peak Formation
Trinity Group, (undifferentiated)
Trinity G

FIGURE GW2 A GENERALIZED GEOLOGIC SECTION B-B' OF THE UPP
(Data from TWC 1963)


B'
DALLAS COUNTY
ELLIS COUNTY
ELLIS COUNTY
HILL COUNTY
Approximate land surface
Austin Group
Eagle Ford Group
Taylor Group
Woodbine Group
Sea level
Fredericksburg and Washita Groups
Paluxy Formation
Glen Rose Formation
Trinity Group
Pennsylvanian and older rocks
900
600
300
300
600
900
1200
1500
1800
2100
2400
2700
3000
ALTITUDE, IN FEET
EXPLANATION
Woodbine aquifer
Paluxy Formation
Travis Peak Formation
Trinity Group, undifferentiated
Trinity Group aquifer
4
0
4
8
12
SCALE IN MILES

IC SECTION B-B' OF THE UPPER TRINITY RIVER BASIN

Because the Paluxy, Glen Rose, and Travis Peak formations are geologically and hydraulically continuous (north of the Glen Rose limestone wedge), there exists a vertical hydraulic connection between the formations, and they frequently have a common piezometric surface and the same quality of water. Moreover, the evaluations of groundwater availability and its characteristics are determined for the Trinity group aquifer, undifferentiated, rather than for each of its three formations.

The Trinity group, undifferentiated, is characterized by fine sand of low transmissibility. Results from pumping tests on the coefficient of transmissibility vary over the area. Several factors which cause a variance in the transmissibility are 1) interbedding of sand and clay, 2) variations in the amount and part of the formation screened by the wells, 3) differences in sorting, deformation, and cementation of sand, and 4) discrepancies in methods and duration of pumping tests.

Available data from pumping tests revealed that the Trinity group, undifferentiated, has a coefficient of transmissibility in the range of 65,000 to 690,000 liters per day per square meter (1,600 to 17,000 gallons per day per square foot) (Baker 1960 and TWC 1963). Coefficients of permeability were found ranging from about 204 liters per day per square meter (5 gallons per day per square foot) in the vicinity of Sherman to more than 4,075 liters per day per square meters (100 gallons per day per square foot) in the Gainesville area of Cooke County. Under artesian conditions, the coefficient of storage was reported in the order of magnitude 0.000065 (TWC 1963).

WOODBINE FORMATION

The Woodbine formation is another major aquifer, and it supplies small to moderate quantities of water to parts of the metroplex area. The formation has a broad wedge of sand and sandy clay which is thickest near the outcrop and thins southeastward. It outcrops in the eastern portions of Cooke, Denton, Tarrant, and Johnson Counties and dips to the southeast at a rate ranging from 6.6 to 19 meters per kilometer (35 to 100 feet per mile).

Field pumping tests made on wells completed in this formation show the aquifer has a low transmissibility. A transmissiblity on the order of 102,000 to 122,000 liters per day per square meter (2,500 to 3,000 gallons per day per square foot) is anticipated in the area north of Dallas County. South of Dallas County, the aquifer is thinner, with a transmissibility on the order of 41,000 liters per day per square meter (1,000 gallons per day per square foot) (TWC 1963). Coefficients of permeability vary from 570 to 2,000 liters per day per square meter (14 to 48 gallons per day per square foot). Available data from pumping tests of 5 wells in Grayson County reveal that storage coefficients ranged from 0.0002 to 0.00002 with an average of 0.00012 (Baker 1960). This general range of storage coefficients can probably be applied for the aquifer in areas to the south (TWC 1963).

AVAILABILITY OF GROUNDWATER

The water-producing capability of an aquifer depends upon its ability to store and transmit water. The availability of groundwater is determined by the balance of recharge and the ability of the aquifer to transmit water to the areas of discharge on a sustained basis. The principal source of groundwater recharge in the Dallas-Fort Worth metroplex area is precipitation which falls on the outcrop of the various aquifers. In addition, seepage from streams and lakes located on the outcrop areas and interformational leakage are sources of groundwater recharge. In essence, recharge is a limiting factor regarding the amount of water that can be developed from an aquifer.

Based on historical data of rainfall recharge, field pumping tests, and some assumptions used for computation, the safe yield of groundwater in the upper Trinity Basin from both the Trinity group and the Woodbine formation is 2.1 and 0.4 cubic meters per second (49 and 10 MGD) respectively (TWC 1963). Total available groundwater in the upper basin is approximately 2.5 cubic meters per second (59 MGD). Such yields are not only based upon theoretical annual recharge rates, but also upon the assumption that wells are properly spaced.

CHEMICAL QUALITY

Groundwater generally remains in contact with rocks for quite some time, and, as a result, it contains a certain amount of dissolved minerals. The kind and concentration of these minerals depend upon the environment, movement, and source of the groundwater. The chemical quality of groundwater, unlike that of contaminated surface water, remains relatively constant with respect to time. Table Nos. XXXVI, XXXVII, and XXXVIII show a chemical quality summary for water samples collected from individual wells since 1969 for Dallas and Tarrant Counties. Total dissolved solids from all formations in Dallas County are rather high.

Water from the Trinity group, undifferentiated, is a sodium bicarbonate type of good quality and is fairly uniform in quality over the metroplex area. Available chemical data reveal that the concentration of dissolved solids generally ranges from 400 to 1000 mg/l. The chloride and sulfate contents are low, although some high values are encountered, and the concentration of total hardness is generally high in the outcrop area, varying from 300 to 400 mg/l. Downdip from the outcrop, the water is soft and in most cases has a total hardness of less than 50 mg/l. Chemical analyses indicate that excessive fluoride concentrations are not present. However, a few instances of high iron contents were reported in some local areas in and near the outcrop. The water quality of the Trinity group, undifferentiated, is generally acceptable for public supplies and industrial uses, although some high chloride and sulfate concentrations were encountered. Treatment, other than chlorination for public supply, does not seem necessary, except in the areas where high iron concentrations occur.

Water from the Woodbine aquifer contains a high concentration of sodium bicarbonate, and it is generally associated with relatively high concentrations of dissolved solids, sulfate, fluoride, and chloride.

TABLE NO. XXXVIII

SUMMARY OF GROUNDWATER QUALITY - WOODBINE FORMATION
(Taken From TWDB 1976)

Constituent or Property	Min. mg/l	Max. mg/l	Mean mg/l	No. of Samples
Dallas County				
Silica (SiO_2)	8.00	32.00	12.75	16
Calcium (Ca)	1.00	25.00	4.43	23
Magnesium (Mg)	0.00	4.00	1.42	21
Sodium (Na)	207.00	922.00	467.39	23
Bicarbonate (HCO_3)	276.00	1013.00	619.56	23
Sulfate (SO_4)	44.00	504.00	320.30	23
Chloride (Cl)	10.00	572.00	127.52	23
Fluoride (F)	1.10	4.50	2.40	22
Nitrate (NO_3)	0.00	1.00	0.48	19
Total Dissolved Solids (TDS)	546.00	2418.00	1236.70	23
Hardness ($CaCO_3$)	3.00	75.00	17.39	23
Specific Cond.	880.00	3130.00	1855.26	19
pH	7.50	8.60	8.11	19
Percent Sodium	93.47	99.57	98.18	21
SAR	22.72	105.19	56.63	21
RSC	4.20	16.02	9.98	21
Tarrant County				
Silica (SiO_2)	11.00	23.00	15.40	5
Calcium (Ca)	16.00	194.00	83.40	5
Magnesium (Mg)	5.00	21.00	13.60	5
Sodium (Na)	32.00	205.00	102.80	5
Bicarbonate (HCO_3)	124.00	378.00	271.00	5
Sulfate (SO_4)	9.00	256.00	133.00	5
Chloride (Cl)	13.00	154.00	87.60	5
Fluoride (F)	0.30	0.90	0.66	5
Nitrate (NO_3)	0.00	27.00	6.46	5
Total Dissolved Solids (TDS)	173.00	927.00	576.05	5
Hardness ($CaCO_3$)	73.00	550.00	264.00	5
Specific Cond.	289.00	1360.00	895.00	5
pH	6.70	7.70	7.40	5
Percent Sodium	29.19	85.96	48.04	5
SAR	1.52	10.45	3.67	5
RSC	0.00	4.09	0.98	5

TABLE NO. XXXIX

SUMMARY OF GROUNDWATER QUALITY - PALUXY FORMATION
(Taken From TWDB 1976)

Constituent or Property	Min. mg/l	Max. mg/l	Mean mg/l	No. of Samples
Dallas County				
Silica (SiO_2)	3.00	19.00	11.75	8
Calcium (Ca)	2.00	47.00	8.91	12
Magnesium (Mg)	1.00	55.00	6.41	12
Sodium (Na)	30.00	546.00	318.15	13
Bicarbonate (HCO_3)	122.00	558.00	403.00	13
Sulfate (SO_4)	12.00	700.00	215.92	13
Chloride (Cl)	22.00	330.00	104.46	13
Fluoride (F)	0.10	16.00	3.07	8
Nitrate (NO_3)	0.20	0.50	0.38	7
Total Dissolved Solids (TDS)	257.00	1757.00	860.18	13
Hardness ($CaCO_3$)	8.00	230.00	49.16	12
Specific Cond.	451.00	1904.00	1384.42	7
pH	7.20	9.20	8.35	12
Percent Sodium	29.35	98.86	90.69	11
SAR	1.06	52.78	32.11	11
RSC	0.00	8.91	6.22	11
Tarrant County				
Silica (SiO_2)	0.00	20.00	11.80	20
Calcium (Ca)	1.00	82.00	6.47	21
Magnesium (Mg)	0.00	11.00	2.00	21
Sodium (Na)	20.00	335.00	209.09	22
Bicarbonate (HCO_3)	321.00	498.00	438.81	22
Sulfate (SO_4)	19.00	158.00	69.95	22
Chloride (Cl)	5.00	125.00	18.72	22
Floride (F)	0.00	2.00	0.74	22
Nitrate (NO_3)	0.00	3.50	1.04	22
Total Dissolved Solids (TDS)	315.00	847.41	534.47	22
Hardness ($CaCO_3$)	2.00	249.00	23.22	22
Specific Cond.	500.00	1160.00	836.76	17
pH	7.70	9.10	8.60	22
Percent Sodium	14.83	99.54	92.83	21
SAR	0.55	68.87	31.80	21
RSC	0.26	7.94	6.67	21

TABLE NO. XL

SUMMARY OF GROUNDWATER QUALITY - TRAVIS PEAK FORMATION
(Taken From TWDB 1976)

Constituent or Property	Min. mg/l	Max. mg/l	Mean mg/l	No. of Samples
Dallas County				
Silica (SiO_2)	4.00	43.00	18.64	14
Calcium (Ca)	2.00	233.00	14.91	24
Magnesium (Mg)	0.00	58.00	3.87	24
Sodium (Na)	182.00	1137.00	433.79	24
Bicarbonate (HCO_3)	222.00	628.00	519.60	25
Sulfate (SO_4)	19.00	2832.00	326.64	25
Chloride (Cl)	64.00	355.00	148.16	25
Fluoride (F)	1.20	10.80	2.56	19
Nitrate (NO_3)	0.20	2.00	0.62	18
Total Dissolved Solids (TDS)	527.00	4497.00	1177.29	25
Hardness ($CaCO_3$)	8.00	824.00	53.83	24
Specific Cond.	880.00	2385.00	1607.20	15
pH	8.00	8.70	8.30	22
Percent Sodium	75.10	99.17	96.61	24
SAR	10.95	66.00	41.34	24
RSC	0.00	9.87	7.93	24
Tarrant County				
Silica (SiO_2)	10.00	20.00	13.50	16
Calcium (Ca)	2.00	6.00	2.81	16
Magnesium (Mg)	1.00	5.00	1.87	16
Sodium (Na)	284.00	427.00	339.68	16
Bicarbonate (HCO_3)	510.00	617.00	551.93	16
Sulfate (SO_4)	73.00	256.00	156.56	16
Chloride (Cl)	44.00	227.00	94.37	16
Fluoride (F)	0.00	7.00	1.70	16
Nitrate (NO_3)	0.09	2.50	0.68	16
Total Dissolved Solids (TDS)	716.71	1133.48	883.69	16
Hardness ($CaCO_3$)	7.00	30.00	14.18	16
Specific Cond.	1137.00	1950.00	1437.76	13
pH	7.80	8.80	8.29	13
Percent Sodium	96.01	98.99	97.89	16
SAR	26.60	59.27	40.82	16
RSC	8.07	9.79	8.74	16

High concentrations of iron appear in several localities, especially near the outcrop. Available data of chemical analyses indicate that total dissolved solids are frequently in excess of 1500 mg/l. The chemical quality of the water from the Woodbine aquifer is usually poor. Electric logs show that generally poorer quality water is encountered in the upper stratum of the Woodbine aquifer, and in most cases only the lower part of the aquifer is developed to supply major wells.

Aeration and filtration processes, in addition to chlorination, may be required to treat for excess iron concentrations, where they occur.

HISTORICAL USE

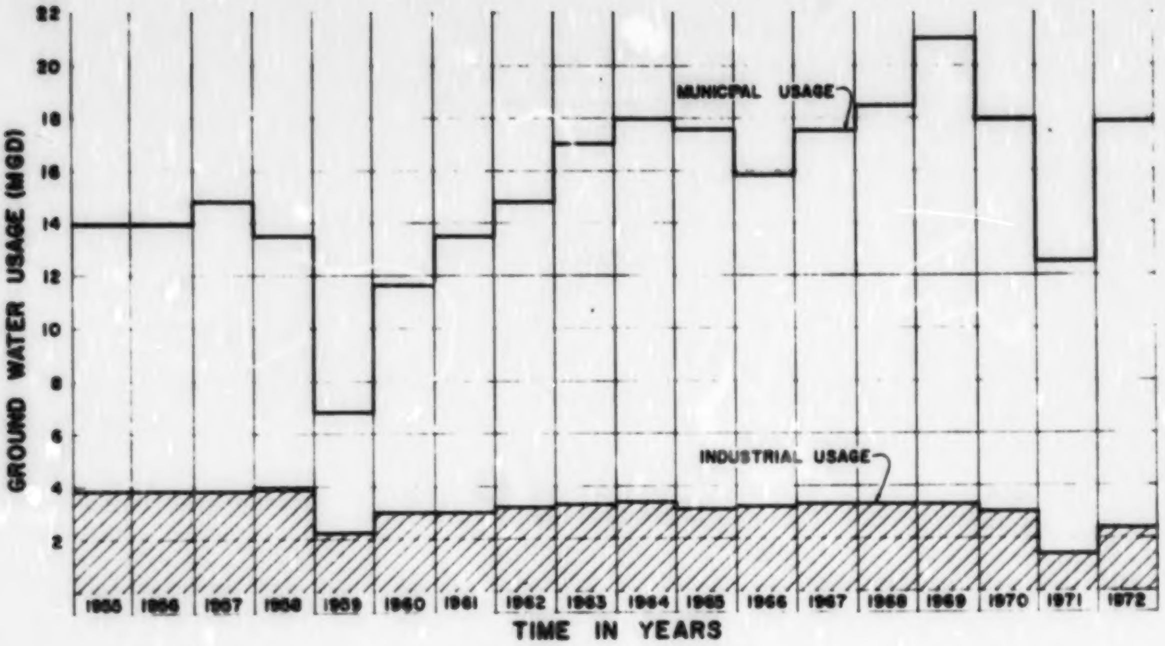
The total safe yield from the aquifers of the Trinity group and the Woodbine formation in the metroplex area is estimated to be approximately 2.6 cubic meters per second (59 MGD). The Trinity group formation is the most prolific and will provide the larger portion of the groundwater supply for Dallas, Denton, Ellis, Johnson, Parker, Tarrant, and Wise Counties. Water from the Woodbine aquifer is widely withdrawn in Collin County, with limited amounts of use in Dallas, Denton, Ellis, and Johnson Counties.

Historically, more than 70 percent of total groundwater pumpage from both aquifers in the upper Trinity has occurred in the metroplex area. About 90 percent of total groundwater used in the metroplex comes from Dallas and Tarrant Counties. Figure GW3 presents the quantities of groundwater used for municipal and industrial usages for Dallas and Tarrant Counties during the period of 1955 to 1972. The figure also reveals that the groundwater use from Dallas and Tarrant Counties has remained practically constant during the period and is almost equivalent to the safe yield of the Trinity Group Aquifer in upper Trinity Basin. The severity of the over-pumpage is evident in a declining water table in the metroplex area. A decline of 235 meters (770 feet) has been reported in Fort Worth (Leggat 1957) while a decline of 91 meters (300 feet) was recorded in Dallas County (Gard 1957). Since the late 1950's, the rate of decline has slowed and in some areas the declines have stopped as the pumping has decreased. Water level decline of selected wells since the early 1950's has been observed (see figures GW4 and GW5).

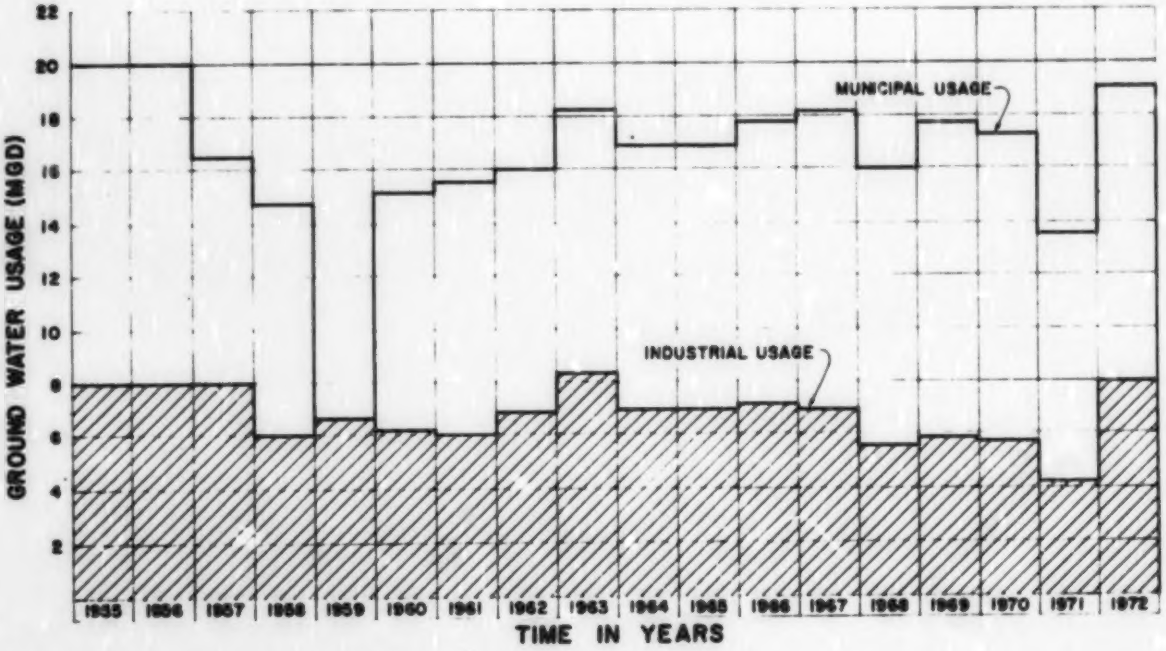
A decreasing trend of using groundwater has been developed. In fact, several small cities solely relying on groundwater have made or are making arrangements to purchase surface water from the City of Dallas, the NTMWD, or the Trinity River Authority.

FUTURE DEVELOPMENT

In the upper Trinity River Basin, the outcrop areas of the Trinity group and the Woodbine aquifers are, respectively, 3110 and 2330 square kilometers (768,000 and 576,000 acres) (TWC 1963), and an average of 81 cm (32 inches) of precipitation falls annually. One inch of annual rainfall as recharge can supply groundwater in the amount of 2.5 and 1.9 cubic meters per second (57 and 43 MGD) from the respective aquifer on a sustained basis. It appears that water received by the aquifers as



TARRANT COUNTY



DALLAS COUNTY

FIGURE GW3 HISTORICAL DATA TRENDS EXHIBITED BY MUNICIPAL AND INDUSTRIAL WATER USAGE IN DALLAS AND TARRANT COUNTIES (Data from NCTCOG 1974)

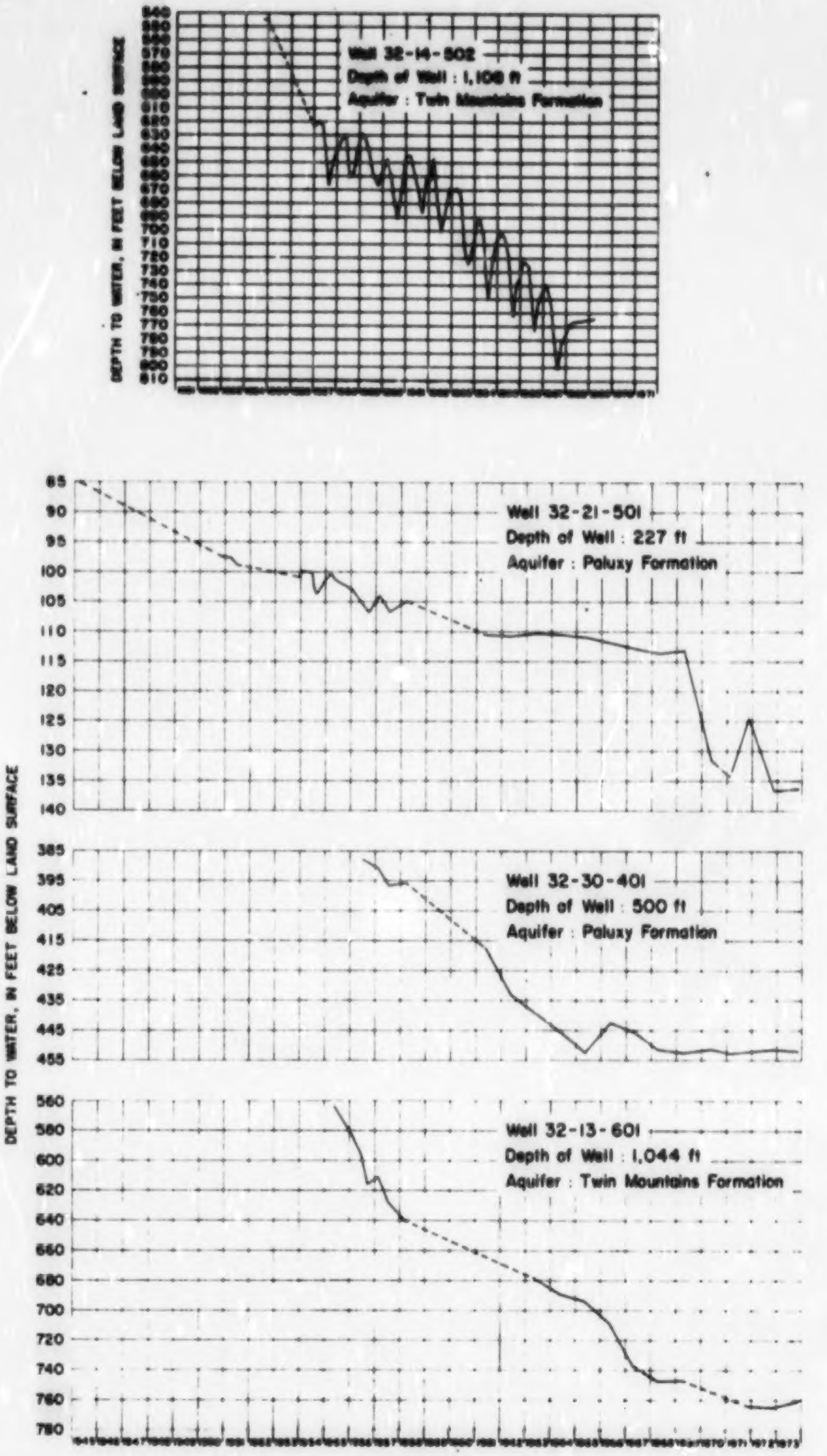


FIGURE GW4 HYDROGRAPHS OF SELECTED WELLS IN TARRANT COUNTY
(Data from TWDB 1976)

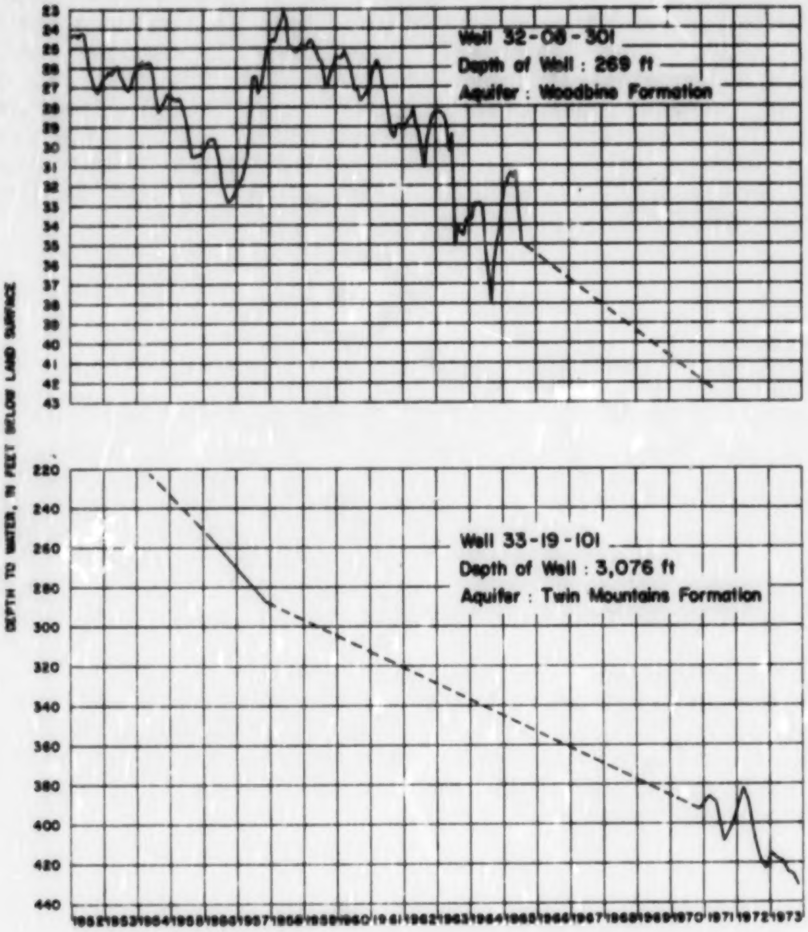


FIGURE GW5 HYDROGRAPHS OF TWO SELECTED WELLS IN DALLAS COUNTY
(Data from TWDB 1976)

recharge will be greater than the amount that can be transmitted to the areas of withdrawals. Obviously, the principal limitation of further use of groundwater in the metroplex area is the aquifers' relatively low coefficient of transmissibility. This will require the spacing of wells or well fields in the entire aquifer to obtain maximum development.

In the metroplex area, over-pumpage has created serious declines in water levels, and additional development there will enhance the related problems. Since pumping levels have lowered, pumping costs will increase, and pumping rates will decrease. In the past two decades, Dallas and Tarrant Counties have experienced the overdevelopment of groundwater, and the area is turning more and more to surface water as a source for water supplies. Development of groundwater in some mid-cities has declined, possibly because of fears of duplicating problems that occurred in the Dallas-Tarrant County area.

SUMMARY

The relatively low coefficient of transmissibility in the aquifers has limited a further development of groundwater in the Dallas-Tarrant County area. Parts of the Trinity group aquifer were locally overdeveloped, and the water levels declined rapidly. Water level decline will result in a lower hydrostatic pressure, which may cause aquifer contamination. A poorly constructed well will permit water with low quality to enter the well and move into a fresh water aquifer having a lower hydrostatic pressure. Oil field operations are a potential source of contamination of groundwater in the metroplex area. Fortunately, however, no contamination was reported in the area.

The spacing of wells or well fields throughout the aquifer area can obtain a maximum development of 2.6 cubic meters per second (59 MGD) on a sustained basis. However, this may not be practical from an economic point of view because of piping and delivering costs. The Trinity group aquifer north of Dallas and Tarrant Counties is capable of more extensive development (TWC 1963).

APPENDICES

SOURCES OF INFORMATION

EXISTING MONITORING PROGRAMS

At present there are seven major agency monitoring programs concerned with accumulating water quality data in the Dallas-Fort Worth 208 area. These programs are executed by (1) the City of Dallas (Dal), (2) the City of Fort Worth (FW), (3) the North Texas Municipal Water District (NTMWD), (4) the Texas Department of Health Resources (TDHR), (5) the Texas Water Quality Board (TWQB), and (6) the U. S. Geological Survey (USGS).

CITY OF DALLAS

The City of Dallas Water Purification Division has been sampling nine stations on the Elm Fork since 1946. The Wastewater Treatment Division began taking samples of the river in the Dallas area in the early 1930's. Sampling by the Wastewater Treatment Division has increased to include twenty stations as of July 1976. The Dallas programs are designed to supply data useful in operating the City's water supply and wastewater treatment operations. Stations may be added or deleted to meet the needs of the City. The following tables show the programs as they exist in June, 1976.

CITY OF DALLAS MONITORING
WATER PURIFICATION DIVISION

Type of Record:

A - Odor, total alkalinity, turbidity, chloride, total hardness, pH, fluoride, total phosphate, orthophosphate, total coliform, fecal coliform - monthly

B - Same as A, plus phytoplankton counts and identification

Location	Station Number	Type of Record
Elm Fork at Lake Lewisville Spillway	1a	B
Elm Fork at SH 121	2a	A
Elm Fork at US 77	3a	A
Denton Creek at Old Denton Road	4a	B
Elm Fork at Carrollton Dam	5a	B*
Elm Fork at Valley View Lane	6a	A
Elm Fork at Royal Lane	7a	A
Elm Fork at California Crossing	8a	A
Elm Fork at Bachman WTP Intake	9a	B

*Algae counts and identification done on Elm Fork WTP raw sample.

CITY OF DALLAS MONITORING
WASTEWATER TREATMENT DIVISION

Type of Record:
- A - Temperature, conductivity, chloride, pH, dissolved oxygen, total organic carbon, turbidity, orthophosphate, total coliform weekly
- B - Same as A, plus BOD_5, total suspended solids - weekly

Location	Station Number	Type of Record
Elm Fork at Lewisville Spillway	1	A
Denton Creek at SH 121	2	A
Elm Fork at Sandy Lake Road	3	A
Elm Fork at Frazier Dam	4	A
West Fork at Meyers Road	5	A
Bear Creek at Meyers Road	6	A
West Fork at West Loop 12	7	A
Mountain Creek at Singleton Road	8	A
Trinity River at Westmoreland	9	A
Trinity River at Corinth Street	10	B
Dallas/White Rock Combined Effluents	11	B
White Rock Creek at Hawn Freeway	12	A
Trinity River at South Loop 12	13	B
Five Mile Creek at US 75	14	A
Trinity River at Malloy Bridge Road	15	A
Ten Mile Creek at Parkinson Road	16	A
East Fork at I-20	17	A
Trinity River at Dowdy Ferry Road	18	A
Trinity River at South Belt Line Road	19	A
Trinity River at SH 34	20	A

CITY OF FORT WORTH

The City of Fort Worth has been collecting and analyzing samples in the Fort Worth area since 1928. The monitoring program currently (mid-1976) in operation by the City has been conducted since 1962.

CITY OF FORT WORTH MONITORING

Type of Record:
- A - Total suspended solids, temperature, dissolved oxygen, biochemical oxygen demand, pH, chloride, ammonia, total organic carbon, turbidity, conductivity, sulfate
- B - Same as A, plus volatile suspended solids, total alkalinity
- C - Same as B, plus Alkyl Benzene Sulfonate (ABS), orthophosphate, and total phosphate
- D - Same as B, plus total dissolved solids
- E - Same as A, plus ABS, orthophosphate, and total phosphate

Location	Station Number	Type of Record
Clear Fork Trinity River @ CRA Bridge	1	A
Clear Fork Trinity River @ Pump Station	2	A
West Fork Trinity River @ 4300 Block, White Settlement Road	3	A
West Fork Trinity River @ North Main St.	4	E
West Fork Trinity River @ N.E. Twelfth St.	5	A
West Fork Trinity River @ Samuels Avenue	6	A
Marine Creek Bridge	7	B
West Fork Trinity River @ N.E. Twelfth St.	8	A
West Fork Trinity River @ East Fourth St.	9	A
Sycamore Creek @ US 80	10	A
West Fork Trinity River @ Beach Street	11	D
West Fork Trinity River @ East First St.	12	C
West Fork Trinity River @ Handley Ederville Road	13	D
West Fork Trinity River @ Precinct Line Road	14	D
West Fork Trinity River @ Arlington-Bedford Road	15	D
West Fork Trinity River @ SH 157	16	D
West Fork Trinity River @ SH 360	17	C

NORTH TEXAS MUNICIPAL WATER DISTRICT

The North Texas Municipal Water District (NTMWD) monitoring program began in 1959 and included eight stations in and around Lake Lavon, as well as stations on the East Fork and Rowlett Creek. The program aids the water district in its water supply functions. During periods when odor problems develop, the frequency of sampling increases, and an emphasis is placed on phytoplankton counts and identification of problem phytoplankton populations in Lake Lavon. Due to lack of equipment, parts of the program were discontinued in 1968 but recommenced during the summer of 1974. The following represents the program as of mid-1976.

NORTH TEXAS MUNICIPAL WATER DISTRICT MONITORING

Type of Record:

- A - Dissolved oxygen, temperature, pH, conductivity, total dissolved solids, total alkalinity, total hardness, chloride, sulfate, nitrate, orthophosphate, total coliform, turbidity, occasional phytoplankton counts
- B - Same as A, plus total suspended solids, volatile suspended solids, ammonia, nitrite, biochemical oxygen demand, fecal coliform
- C - Dissolved oxygen, temperature, pH, conductivity, total dissolved solids, total suspended solids, chloride, sulfate, ammonia, orthophosphate, biochemical oxygen demand, fecal coliform

Location - Lake Lavon Area	Station Number	Type of Record	Period of Record
Intake number 1 near Lavon Dam**	L1	A	2
Intake number 2 at East Fork Harbor**	L2	A	2
Near Garland Power Plant**	L3	B	2
Elm Creek at SH 78**	L4	A	2
Midlake - Pilot Grove Arm**	L5	A	1
Ticky Creek near FM 982**	L6	A	2
Wilson Creek north of Highland Park**	L7	A	2
Midlake - East Fork Arm**	L8	A	1
Location - Rowlett Creek Basin			
Rowlett Creek @ Los Rios Boulevard*	R1	C	3
Rowlett Creek @ FM 544*	R2	C	3
Rowlett Creek @ Blackburn Road*	R3	C	3
Rowlett Creek @ Parker Road**	R4	C	3
Rowlett Creek @ SH 78**	R5	C	3
Location - East Fork Trinity River			
East Fork above S. Mesquite Creek*	1	C	3
East Fork @ Malloy Bridge Road*	2	C	3
East Fork above Duck Creek**	3	C	3
East Fork @ FM 3039**	4	C	3
East Fork near Confluence**	5	C	3

Period of Record:
1 - 1959-1968, 1974 to present
2 - 1959 to present
3 - April, 1976 to present

*Sampled weekly
**Sampled monthly

TEXAS DEPARTMENT OF HEALTH RESOURCES

The Texas Department of Health Resources (TDHR) began monitoring bacterial levels in the Trinity River Basin during the mid-1960's. The program has remained essentially the same since its beginning. Total and fecal coliform analyses are performed quarterly.*** The only TDHR station in the Dallas-Fort Worth 208 area is the Trinity River at SH 34, South of Rosser, Kaufman County.

***Heavy metal analyses (cadmium, chromium, lead, mercury) are performed annually.

TEXAS WATER QUALITY BOARD

The Texas Water Quality Board monitoring program for the Trinity River Basin began with the Board's first operations in 1967. As the chief water quality agency in the State, the purposes of its monitoring program include determining where pollution problems exist, measuring the effect of pollution abatement actions over a period of time, and enforcement.

Since 1967, the program has increased greatly in stations, parameters, and frequency. The following table represents the program as of September 1, 1976.

At present, the TWQB is conducting an "intensive study" of Lake Ray Hubbard, utilizing more stations than are listed in the following table. The Lake Ray Hubbard stations listed therein (i.e., 0820.01, 0820.02, 0820.03) represent the stations from which data were taken for the purposes of this report. All other stations and Type of Record designations represent the sampling program as of September 1, 1976.

TEXAS WATER QUALITY BOARD MONITORING

Type of Record:

C = Chemical
- a. Temperature, dissolved oxygen, pH, conductivity, total dissolved solids - monthly
- b. Same as a., and including total suspended solids, volatile suspended solids, ammonia, nitrate, dissolved and total orthophosphate, total phosphate, chloride, sulfate, fecal coliform, chlorophyll a - monthly
- c. Same as b. - quarterly
- d. Same as b. - annually

B = Biological
- a. Benthic macroinvertebrate communities - quarterly
- b. Phytoplankton and Zooplankton communities - quarterly
- c. Periphyton communities - quarterly
- d. Macrophyte communities - annually

M = Metals

The following parameters will be measured in water.
- a. monthly
- b. annually

Arsenic
Barium
Boron
Cadmium
Chromium (total)
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Zinc

Continued. . .

S = Sediment

- Arsenic
- Barium
- Boron
- Cadmium
- Copper
- Chromium (total)
- Lead
- Manganese
- Mercury
- Nickel
- Herbicides
  - Silvex
- Selenium
- Silver
- Zinc
- Total phosphate
- Chemical oxygen demand
- Kjeldahl nitrogen
- Volatile solids
- Oil and grease
- Total organic carbon
- PCB
- Insecticides
  - Aldrin
  - Chlordane
  - Chlorthion
  - DDD
  - DDE
  - DDT
  - Diazinon
  - Dieldrin
  - Endrin
  - Heptachlor
  - Heptachlor Epoxide
  - Lindane
  - Methoxychlor
  - Methyl Parathion
  - Parathion
  - Toxaphene

Location	Station Number	Type of Record
Benbrook Reservoir at midlake near dam	0830.01	Cc
Clear Fork Trinity River at Bryant-Irvin Street in Fort Worth	0829.01	CcBd
Lake Arlington at midlake near dam	0828.01	CcBbS
White Rock Lake at midlake near dam	0827.01	Cc
Grapevine Reservoir at midlake near dam	0826.01	Cc
Denton Creek at SH 121 west of Lewisville	0825.01	Cc
Lake Lewisville at Hickory Creek Arm	0823.01	CcBb
Lake Lewisville at Elm Fork Arm	0823.02	Cd
Lake Lewisville at midlake near dam	0823.03	Cd
Elm Fork Trinity River at SH 356 at Dallas	0822.01	Cb
Elm Fork Trinity River at Carrollton Dam west of Carrollton	0822.02	Cb
Lake Lavon at East Fork Arm	0821.01	CcS
Lake Lavon at Pilot Grove Arm	0821.02	Cd
Lake Lavon at midlake near dam	0821.03	Cd
Lake Ray Hubbard at Rowlett Creek Arm	0820.01	CcS
Lake Ray Hubbard at East Fork Arm	0820.02	Cc
Lake Ray Hubbard at midlake near dam	0820.03	CcBb
East Fork Trinity River at US 175 northwest of Crandall	0819.01	CbBcMbS
Lake Worth at Ten Mile Bridge Road in Ft. Worth	0808.01	Cc
Lake Worth at midlake near dam	0807.01	CcBb
West Fork Trinity River at East Northside Drive in Fort Worth	0806.01	CaCc
West Fork Trinity River at River Oaks Blvd. (SH 183) in Fort Worth	0806.02	CbMa
Trinity River at SH 34 southwest of Rosser	0805.01	CaCcBaBcMbS
Trinity River at Belt Line Road east of Wilmer	0805.02	CaCc

Continued. . .

Location	Station Number	Type of Record
Trinity River at South Loop 12 south of Dallas	0805.03	CbBaBbBcMaS
Trinity River at Commerce Street in Dallas	0805.04	CaCc
West Fork Trinity River at Belt Line Road in Grand Prairie	0805.05	CaCcBaMbS
West Fork Trinity River at Randol Mill Road south of Richland Hills	0805.06	CaCcBd
West Fork Trinity River at Beach Street in Fort Worth	0805.07	CaCcBaBcS

U. S. GEOLOGICAL SURVEY

The Survey's program includes both water quantity and water quality monitoring. While the Survey operates the program, the cost of most of the operations is split, 50% federal, 9% State, and 41% either local or State. The State of Texas is represented primarily by the Texas Water Development Board, which in turn, considers the desires of the Texas Water Quality Board, the Texas Water Rights Commission, and other central State agencies. The local cooperators include river authorities, cities, special water districts, and others.

The Survey operates on a Water Year, from October 1 to September 30, which is timed to avoid starting the annual record in the middle of a period which normally includes minimum or maximum streamflows, so that the complete range of the cycle may be shown in each year of record.

The USGS has been collecting water quality data in the Dallas-Fort Worth 208 area since 1954. The following table summarizes the program as of June, 1976 (USGS 1976a).

U. S. GEOLOGICAL SURVEY MONITORING

Type of Record:

Dd = Stream stage (digital) at least daily, often continuous

Op = Organic-quality: Nitrate, nitrite, phosphate, specific conductance, pH, temperature, dissolved oxygen, biochemical oxygen demand (five-day) - 6 to 12 per year

P = Pesticides: Aldrin, DDD, DDE, DDT, Dieldrin, Endrin, Heptachlor, Heptachlor Epoxide, Lindane, Chlordane, PCB, Diazinon, Malation, Parathion, Methyl Parathion, 2,4-D, 2,4,5-T, Silvex - 4 to 12 times per year

Q = Chemical-quality: Usually silica, calcium, magnesium, sodium + potassium, bicarbonate, carbonate, sulfate, chloride, fluoride, nitrate, dissolved solids, hardness, specific conductance, pH, temperature - daily

Qp = Same as Q, except only about once a month

R = Reservoir stage and content - at least daily, often continuous

Continued. . .

Sp = Periodic sediment: Aldrin, DDD, DDE, DDT, Dieldrin, Endrin, Heptachlor, Heptachlor Epoxide, Lindane, Chlordane, PCB - 4 times per year
G = Gage heights only
H = Flood-hydrograph partial-record station

Location	USGS Station Number	Type of Record	Year Water Quality Record Began
Lake Worth above Fort Worth	08045400	Qp	-
Benbrook Lake near Benbrook	08046500	QpR	1969
Clear Fork Trinity River near Benbrook	08047000	Dd	-
Clear Fork Trinity River at Fort Worth	08047500	Dd	-
West Fork Trinity River at Fort Worth	08048000	DdQpOp	1967
Sycamore Creek at IH 35-W, Fort Worth	08048520	Dd	-
Sycamore Creek tributary above Seminary South Shopping Center, Fort Worth	08048530	Dd	-
Sycamore Creek tributary at IH 35-W, Fort Worth	08048540	Dd	-
Dry Branch at Blandin Street, Fort Worth	08048550	H	-
Dry Branch at Fain Street at Fort Worth	08048600	Dd	-
Big Fossil Creek at Haltom City	08048800	G	-
Little Fossil Creek at IH 820, Fort Worth	08048820	H	-
Little Fossil Creek at Mesquite Street at Fort Worth	08048850	Dd	-
Lake Arlington at Arlington	08049200	RQpOp	1969
West Fork Trinity River at Grand Prairie	08049500	DdQOp	1956
Big Bear Creek near Grapevine	08049550	Dd	-
Mountain Creek near Cedar Hill	08049600	DdQpOp	1974
Walnut Creek near Mansfield	08049700	Dd	-
Mountain Creek near Duncanville	08049900	GQpOp	1974
Mountain Creek Lake near Grand Prairie	08050050	RQp	1969
Mountain Creek at Grand Prairie	08050100	Dd	-
Little Elm Creek near Aubrey	08052700	Dd	-
Lake Lewisville near Lewisville	08052800	OpQpR	1969
Elm Fork Trinity River near Lewisville	08053000	Dd	-
Grapevine Lake near Grapevine	08054500	QpR	1969
Denton Creek near Grapevine	08055000	Dd	-
Elm Fork Trinity River near Carrollton	08055500	Dd	-

Continued. . .

Location	USGS Station Number	Type of Record	Year Water Quality Record Began
Joes Creek at Royal Lane, Dallas	08055580	H	-
Joes Creek at Dallas	08055600	H	-
Bachman Branch at Dallas	08055700	Dd	-
Turtle Creek at Dallas	08056500	Dd	-
Trinity River at Dallas	08057000	Dd	-
Coombs Creek at Sylvan Avenue, Dallas	08057020	H	-
Cedar Creek at Bonnie View Road, Dallas	08057050	H	-
White Rock Creek at Keller Springs Road at Dallas	08057100	Dd	-
Spanky Branch at McCallum Lane, Dallas	08057120	H	-
Rush Branch at Arapaho Road, Dallas	08057130	H	-
Cottonwood Creek at Forest Lane, Dallas	08057140	H	-
Floyd Branch at Forest Lane, Dallas	08057160	H	-
White Rock Creek at Greenville Avenue, Dallas	08057200	Dd	-
White Rock Creek at White Rock Lake at Dallas	08057300	Dd	-
Ash Creek at Highland Road, Dallas	08057320	H	-
White Rock Creek at Scyene Road at Dallas	08057400	Dd	-
Trinity River below Dallas	08057410	DdQOpPSp	1967
Elam Creek at Seco Boulevard, Dallas	08057415	H	-
Fivemile Creek at Kiest Boulevard, Dallas	08057418	H	-
Fivemile Creek at U.S. Highway 77, Dallas	08057420	H	-
Woody Branch at U.S. Highway 77, Dallas	08057425	H	-
Fivemile Creek at Lancaster Road, Dallas	08057430	H	-
Newton Creek at IH 635, Dallas	08057435	H	-
Whites Branch at IH 635, Dallas	08057440	H	-
Prairie Creek at Jennie Lee Street, Dallas	08057442	H	-
Prairie Creek at U.S. Highway 175, Dallas	08057445	Dd	-
Hattfields Branch at Seagoville Road, Dallas	08057447	H	-

Continued. . .

Location	USGS Station Number	Type of Record	Year Water Quality Record Began
Tenmile Creek at State Highway 342 at Lancaster	08057450	Dd	-
East Fork Trinity River at McKinney	08058900	Dd	-
Sister Grove Creek near Blue Ridge	08059400	Dd	-
Lavon Lake near Lavon	08060500	RQp	1969*
East Fork Trinity River near Lavon	08061000	Dd	-
Rowlett Creek near Sachse	08061540	Dd	-
Lake Ray Hubbard near Forney	08061550	RQp	1969
Duck Creek at Buckingham Road, Garland	08061620	H	-
Duck Creek near Garland	08061700	Dd	-
East Fork Trinity River near Forney	08061750	Dd	-
South Mesquite Creek at SH 352, Mesquite	08061920	H	-
South Mesquite Creek at Mercury Road near Mesquite	08061950	Dd	-
East Fork Trinity River near Crandall	08062000	DdQOp	1967
Trinity River near Rosser	08062500	DdQOpP	1954

*Water quality program terminated in 1974.

ADDITIONAL SOURCES OF INFORMATION

The purpose of this section is to provide a synopsis of the various major sources of information not falling under the category of Monitoring Programs.

CITY OF DALLAS

At present, the City of Dallas has a continuing Urban Runoff Sampling Program. Wet weather sampling data, which apply to Segments 0805 and 0822, have been produced from runoff events sampled in early November 1975 and May 1976.

TEXAS PARKS AND WILDLIFE DEPARTMENT (TPWD)

Numerous fish surveys have been turned out by the TPWD for lakes in the Dallas-Fort Worth 208 area. Lakes covered by these reports include Benbrook, Worth, Arlington, Grapevine, Lewisville, and North. The period of time covered by the various reports is 1954-1976.

TRINITY RIVER AUTHORITY OF TEXAS

The Trinity River Authority began sampling the upper Trinity River Basin in June 1972. While TRA does not have a formalized monitoring program going at present, it has over the years accumulated a substantial amount of water quality data for the area now referred to as the Dallas-Fort Worth 208 Area. TRA has collected water quality data within segments 0805, 0819, 0822, and 0825.

RYCKMAN, EDGERLEY, TOMLINSON, AND ASSOCIATES, INC. (RETA 1974)

This source provides a substantial amount of quantitative and qualitative information on benthic macroinvertebrate species present. Segments covered are 0805, 0806, and 0825.

VARIOUS THESES AND DISSERTATIONS

Pettitt (1976) has compiled a complete listing of theses dealing with the water quality of surface waters in the state of Texas for the period 1897-1975. A substantial number of these pertained to the Dallas-Fort Worth 208 Area.

CONVERSION FACTORS

TO CONVERT	TO	MULTIPLY BY
Units of Length		
inches (in)	centimeters	2.54*
feet (ft)	meters	0.3048*
yards (yd)	meters	0.9144*
miles (mi)	kilometers (km)	1.609344*
centimeters (cm)	inches	0.3937008*
meters (m)	feet	3.280840
meters	yards	1.093613
Units of Mass		
grains (gr)	grams (g)	0.06479891*
ounces (oz) (avdp)	grams	28.349523125*
pounds (lb) (avdp)	grams	453.59237*
grams	grains	15.43236
grams	ounces (avdp)	0.03527396
kilograms (kg)	ounces (avdp)	35.27396
kilograms	pounds (avdp)	2.204623
Units of Area		
acres (a)	square miles	0.0015625*
acres	hectares (ha)	0.40468564224*
acres	square kilometers	0.004046856
square miles	hectares	258.9988110336*
square miles	square kilometers	2.589988
hectares	square miles	0.00386102
square meters (m^2)	hectares	0.0001*
square kilometers	acres	247.1054
square kilometers	square miles	0.3861022
Units of Volume		
gallons (gal)	cubic feet (ft^3)	0.1336806
gallons	cubic meters (m^3)	0.003785411784*
cubic feet	liters (l)	28.316846592*
cubic feet	gallons	7.480519
cubic feet	cubic meters	0.028316846592*
acre-feet	gallons	325851.3
acre-feet	cubic meters	1233.482
milliliters (ml)	cubic inches (in^3)	0.06102374
milliliters	liquid ounces	0.03381402
liters	liquid quarts (qt)	1.056688
liters	cubic feet	0.03531467
cubic meters	cubic feet	35.31467
cubic meters	gallons	264.17205
cubic meters	liters	1000*

continued. . .

TO CONVERT	TO	MULTIPLY BY
Units of Flow		
cubic feet per second (cfs)	cubic meters per second	0.028316846592*
million gallons per day (mgd)	cubic feet per second	1.547229
million gallons per day	cubic meters per second	0.0438125
cubic meters per second	cubic feet per second	35.31467
gallons per day per ft^2	liters per day per m^2	40.74583
liters per day per m^2	gallons per day per ft^2	0.0245454
Miscellaneous Units		
feet per mile (slope)	meters/kilometer (slope)	0.1893939
meters/kilometer (slope)	feet per mile (slope)	5.28*

*Figures are exact, others are given to seven significant figures.

RECOMMENDED UNIT PREFIXES *

Multiples and Submultiples	Prefixes	Symbols
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka (deca)	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	u
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

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* Taken from Standard Mathematical Tables (1973).

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________. 1957b. Fisheries investigations and surveys of the waters of Region IV-B (Lake Arlington, Bear Creek, Clear Fork, Mustang Creek, Rocky Creek). TPWD, Austin, Texas. 28 pp. This report provides data collected during 1957 in several bodies of water. Data from fishes caught during gill netting sessions are presented in tabular form.

________. 1958. Fisheries investigations and surveys of the waters of Region IV-B. (Benbrook Lake). TPWD, Austin, Texas. 37 pp. A list of one-year netting results from Benbrook Lake. Average lengths, weights, and percents are given for each species in tabular form.

________. 1961. Resurvey and appraisal of several public waters in Region IV-B. (Benbrook Lake, Lake Worth). TPWD, Austin, Texas. 12 pp. The results of a population survey of the various fishes located in Benbrook Lake and Lake Worth.

________. 1962. Fisheries investigations and surveys of the waters of Region IV-B. (Lake Arlington, Benbrook Lake, Lake Worth). TPWD, Austin, Texas. 22 pp. The results of gill netting in three Texas lakes. All data are listed in tabular form and various population parameters are discussed.

________. 1963. Fisheries investigations and surveys of the waters of Region II-A. (Benbrook Lake, Lake Worth). TPWD, Austin, Texas. 13 pp. The results of an investigation on the community of fishes in Lake Worth and Benbrook Lake.

________. 1964. Fisheries reconnaissance. Region II-A (Lake Grapevine). TPWD, Austin, Texas. 12 pp. A job completion report listing the results of gill netting in Lake Grapevine. Gamefish and rough fish are listed along with average weights, length, and percent of catch.

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Texas Parks and Wildlife Department. 1972. Region II-A fisheries studies. (Lake Lewisville). TPWD, Austin, Texas. 33 pp. The tabulated results of gill nettings on Lake Lewisville are presented. The captured fish are listed by common name.

________. 1973. Region II-A fisheries studies. (Lake Lewisville). TPWD, Austin, Texas. 23 pp. The fish caught in this survey are listed by common names. Physical parameters such as average length, weight and percent of catch are tabulated.

________. 1976a. Existing reservoir and stream management recommendations. District II-A (Lake Lewisville). TPWD, Austin, Texas. 56 pp. This publication recommends habitat improvement, fisherman information, fish population manipulation, vegetation control, and pollution control for Lake Lewisville.

________. 1976b. Existing reservoir and stream management recommendations. District II-C (Benbrook Lake). TPWD, Austin, Texas. 65 pp. This report provides complete physicochemical information as well as information on the fish community in Benbrook Lake.

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Texas Water Development Board. 197?. Preliminary reports of the Dallas-Fort Worth complex water supply study, part 2 (unpublished). The report projects water requirements for the upper Trinity River Basin. An effort is also made to compare these requirements with projected supply from existing sources and determine when and where supply shortages will develop.

________. 1976. Water level and water quality data from observation wells in Northeast Texas, Report 198. Basic quantitative and qualitative information concerning groundwater in Northeast Texas is reported. Data tabulations include current and historical water level measurements, chemical analyses, and summaries of quality by aquifers. Groundwater pumping for industrial and municipal uses is also presented.

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_______. 1974a. Intensive surface water monitoring survey for Segment 0823 (Lake Lewisville). Report No. IMS-5. TWQB Field Operations Division, Austin, Texas. 36 pp. This report presents a survey of water quality conditions in Lake Lewisville, including the effects of tributary inflows to the eutrophication process in the reservoir. Analyses for various chemical and biological parameters were also conducted.

_______. 1974b. Intensive surface water monitoring survey for Segment No. 0821 (Lake Lavon). Report No. IMS-6. TWQB Field Operations Division, Austin, Texas. 31 pp. This report presents a survey of water quality conditions in Lake Lavon, including the effects of tributary inflows to the eutrophication process in the reservoir. Analyses for various chemical and biological parameters were also conducted.

_______. 1974c. Intensive surface water monitoring survey for Segment No. 0820 (Lake Ray Hubbard). Report No. IMS-8. TWQB Field Operations Division, Austin, Texas. 28 pp. This report presents a survey of water quality conditions in Lake Ray Hubbard, including the effects of tributary inflows to the eutrophication process in the reservoir. Analyses for various chemical and biological parameters were also conducted.

_______. 1975a. Water quality segment report for Segment Nos. 0804 and 0805 Trinity River. Report No. WQS-7. TWQB, Austin, Texas. 42 pp. A summary of the water quality data in the Trinity River above Lake Livingston. Certain information on coliform bacteria and benthic macroinvertebrates is given.

_______. 1975b. Water quality segment report for Segment No. 0819-East Fork of the Trinity River. Report No. WQS-1 (revised). TWQB, Austin, Texas. 34 pp. A summary of water quality data in the East Fork of the Trinity River. Information on dissolved nutrients, minerals, and sewage effluents is also given.

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_______. 1976a. Texas water quality standards. TWQB, Austin, Texas. 79 pp. A list of the maximum and minimum allowable concentrations of various water constituents. Listings of criteria are given for waters ranging from raw water sources to sewage dominated inland streams.

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16. Abstracts

This document presents existing and available water quality data, both recent and historical, for the Dallas-Fort Worth 208 Area. Consideration is given to water analyses , tributary analyses, and sediment analyses, as well as various biological parameters. Temporal and spatial trends are examined.

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